# Popular Astronomy

Vol. XLV, No. 6 JUNE-JULY, 1937 Whole No. 446

## Lunar Changes in the Neighbourhood of Pico and Pico B

By G. O. RAWSTRON

In POPULAR ASTRONOMY, Vol. 23, No. 3, an article appeared by Professor W. H. Pickering, entitled "Meteorology of the Moon," describing irregular changes which occur in the appearance of certain lunar surface formations. Special attention was given in this paper to the isolated mountain known as Pico, situated on the Mare Imbrium a little south of Plato. The changes noted were attributed, not to the continu-

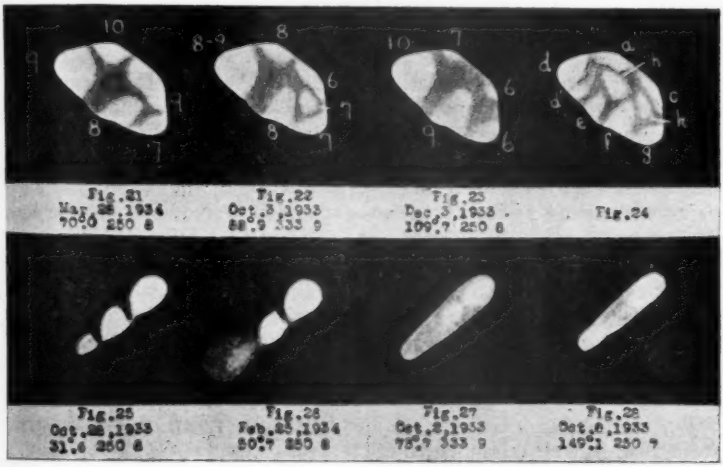



FIGURE 1
DRAWINGS OF PICO AND PICO B

ously varying angle of the incident light, but to actual differences in the surface appearance brought about by meteorological conditions—notably the formation of hoar frost, or the deposition and subsequent melting of snow.

Considerable literature has appeared from time to time on this subject, especially from the pen of Professor Pickering, and, to a smaller extent, in the publications of the British Astronomical Association, but, for some reason, of recent years further investigation appears to have been rather neglected. It is the object of these short notes to describe

certain conspicuous changes which take place in the appearance of the Mare Imbrium surrounding Pico and Pico B (the elongated three-peaked mountains to the south of Pico), and to confirm, as far as possible with the limited aperture available, the changes noted by Professor Pickering on Pico itself.

It cannot be over-emphasized that it is practically impossible to reconcile these changes with the effect of the varying angle of illumination. There are certain markings which actually darken as the lunar mid-day approaches; certain others vary considerably in shape and size during the course of a lunation. Most striking of all, however, are those areas which undergo an irregular change in appearance from one lunation to the next—that is to say, which do not present the same aspect at similar colongitudes, even after due allowance has been made for any effect which may be attributable to libration.

Figs. 1 to 23 (Plate IV and Figure 1) are drawings of the isolated mountain Pico and certain light markings which appear on the Mare Imbrium in the neighbourhood of this peak. In all, the mountain has been observed on sixty-five different dates during 1933 and the first half of 1934, forty-eight drawings being made. Figs. 25 to 28 (Figure 1) are drawings of the three-peaked mountain Pico B. The general appearance of this mountain and the surrounding Mare was noted on each occasion when Pico was observed, but drawings were not always made, the total number of drawings of this mountain being thirty-four. The instrument used was a 4-inch Cooke refractor, the quality of the glass being such that a 15-inch eyepiece, giving a power of 333, can be used to advantage under the most favourable seeing conditions. Under each drawing the first figure (of the third line) indicates the colongitude, the second the magnification employed, and the third the quality of the seeing on a scale of 12. The method of orientation used by Professor Pickering for the illustrations of Pico in the previously mentioned article (Pop. Ast., Vol. 23, Plate VIII) has been adopted here; *i.e.* the Figures are reproduced with the north at the top.

Before describing the observations it may be noted that (to quote from Professor Pickering's paper): "The mountain (Pico) is situated in longitude 9°, latitude +45°. Its vernal equinox therefore occurs at colongitude 9°, its summer solstice at 99°, or just after full moon, and its autumnal equinox at 189°." However, owing to the altitude of the mountain (8000 feet), the sun touches its summit shortly before colongitude 7°.

The drawings represent the mountain as accurately as possible, exactly as seen through the telescope—the only point which has been slightly exaggerated to ensure satisfactory reproduction is the contrast between the light and dark areas on Pico itself. These are often difficult to distinguish when actually observing, particularly early and late in the lunation. The writer does not find the mountain quite so elongated in shape as represented by Professor Pickering—the photographs in Pick-

ering's Lunar Atlas tend to confirm this more shortened form, particularly Plates 7C 79° and 9C 97° where the outline of the mountain is well shown. Owing to the fact that Pico is situated well away from the limb, its apparent outline is not much altered by the effects of libration. Figure 24 does not represent the mountain as seen at any particular time, but serves to indicate the positions of *all* the spots observed from here on different occasions. The shapes and sizes of these spots are not necessarily as shown in this illustration, as these vary considerably during the lunation—their positions only are indicated. The nomenclature adopted by Professor Pickering has been employed throughout with the exception of slight differences in the lettering used on the western side of the mountain.

By far the most conspicuous change to be noted is the white marking which spreads out from the northeastern corner of Pico and gradually extends over the Mare Imbrium to the southeast until it reaches over the plain for a distance equal to about twice the length of Pico itself—that is to say, until it is about 22 miles long. The following are some of the more interesting points connected with this light marking:

(1) During different lunations it makes its first appearance at dissimilar colongitudes. At colongitude 35°.4 (Fig. 2) the white marking (henceforth referred to as "haze") was recorded as "faint, but quite definite." At 38°.9 (Fig. 3) the entry made was "no trace of haze visible." Usually it has been found here that distinct haze appears, spreading from the northeast corner of the mountain (the vicinity of spots d and d′), as early as colongitude 42°. Professor Pickering, however, in the article "Meteorology of the Moon," does not record the appearance of any haze before colongitude 64°.8. Plate 11B 54° of Pickering's Lunar Atlas shows the commencement of this haze well. It can be seen as a distinct white patch on the plain, only slightly darker than Pico itself. If this patch is measured it can easily be verified that it extends too far across the Mare for it to be a white area making its appearance on the mountain itself.

(2) The brightness of the white marking, or haze, does not reach its maximum either at the mountain's summer solstice, or when the Moon is full. In addition, at neither of the above times does the haze extend over the Mare to its greatest extent. Normally, it has been found here that the maximum brilliance is reached at about colongitude 60°; after 60° the streak of haze gradually spreads southwards, at the same time broadening out and becoming fainter, until by colongitude 130° it has usually become so extended and diffuse that it is difficult to distinguish from the surrounding Mare.

(3) At similar colongitudes during different lunations the haze does not always present the same appearance. Note particularly Figs. 4 and 5, and Figs. 14 and 15.

(4) More striking perhaps than the above differences are the changes

exhibited by spots d and d'. These spots appear to be in some manner connected with the source of the haze. The changes are most conspicuous between colongitudes 35° and 75° (Figs. 2 to 10). So striking were the differences observed in the appearance of these spots at almost exactly similar colongitudes (during different lunations) that at first the writer suspected the drawings must be in error. Subsequent drawings, however, made with the greatest care, all tend to confirm these changes. In Fig. 4 (42°.2) it will be noted that no light spot is visible in the locality usually occupied by spots d or d'; in Fig. 5 (42°.5), however, a spot shows plainly in this position (the N.E. corner of the mountain). This spot was recorded as "throwing a distinct shadow across the Mare, but perhaps not so dark as the shadow from spot a." In Fig. 6 two spots are shown on this area, and it will be noted that, although it is now colongitude 49°.6, the haze itself is not so far advanced as in the previous Figure. In Figs. 7 and 8 spot a has much increased in size, but no spots are visible at d or d'. Spot d appears as a "very white area with a slightly hazy boundary" in Fig. 9. Professor Pickering has noted this haziness of spot d on many occasions, and full details are given in Vol. 23, No. 3, of POPULAR ASTRONOMY.

It seems to be fairly certain from the occasional early appearances of a light marking on the locality of spot d, and its subsequent irregular disappearances and reappearances, that, when this spot first shows, it cannot be due merely to the sun striking on the northeastern peak of the mountain. It is difficult also to account for these variations with the theory of the deposition and melting of snow, or the formation of hoar frost, as, on several occasions between colongitudes 42° and 50°, the light marking at d has been seen to throw a distinct shadow. It is interesting to note that in Figs. 7 and 8, colongitudes 52°.3 and 61°.1, neither the spot nor shadow is recorded. The only feasible explanation appears to be that the appearance of this light patch in the locality of d at colongitudes earlier than 60°-65° is due to some kind of cloud formation, or possibly a jet of volcanic steam, although, if the latter view is taken, it is difficult to explain why this should be most active only between colongitudes 35°-65°.

No other spots on the mountain present such marked changes as d and d' exhibit during this period, but small irregular changes are to be noted during the course of the lunation in the majority of the spots. Professor Pickering has dealt with these in much detail in his paper, "Meteorology of the Moon." As previously stated, it has been difficult here with the limited aperture to confirm these observations. Although the seeing in this locality is excellent at times, occasionally perfect with a 4-inch (star discs well defined and diffraction rings quite steady), it is seldom that a number of consecutive nights of this type are obtained. As a result, although very fine detail may be observed occasionally, it is difficult to make anything approaching a complete series of drawings throughout a lunation all showing a similar amount of detail. The ma-

jority of spots noted by Professor Pickering have been observed here on occasions, and three typical drawings, with lettering indicating the relative brightness of the markings, are reproduced in Figure 1, Figs. 21 to 23. The change in the position angle of f is interesting—this spot usually lies almost in a north-south direction, but in Figs. 10 and 21 it is shown running very approximately east and west. These are the only two occasions on which it has been observed lying in this direction.

Figs. 25 to 28 are drawings of the three-peaked mountain Pico B, situated a little to the south of Pico. This mountain carries three white spots which present more irregular, and also perhaps more easily detected, variations than the light markings on Pico. A rather striking change is shown in Fig. 26, colongitude 50°.7, when a large patch of haze appeared from the eastern end of this mountain and drifted off across the Mare in approximately the same direction as the haze from Pico. This haze has been observed on two other occasions: September 1, 1933, colongitude 57°.5, and October 1, 1933, colongitude 52°.4. In each case a rather different appearance was presented from Fig. 25. On September 1, 1933, the haze was recorded as being much more extended, but more symmetrical in shape, not presenting the marked protuberance towards the shadowed side of the mountain as in Fig. 26. On October 1, 1933, it was considerably narrower and more elongated than on either of the above occasions. Professor Pickering has once recorded this haze spreading from the eastern end of Pico B—this was on September 25, 1912, colongitude 90°.4, a much later colongitude than any occasion on which it has been observed here; he records the mountain as "steaming vigorously at its eastern end, the steam drifting off across the Mare towards the north."

The ideal material for investigating these interesting changes would be a complete series of photographs of a standard of excellence similar to those obtained at Mt. Wilson. The photographs should not be of the terminator only, but of certain selected regions where variations are suspected—Plato, Eratosthenes, Endymion, Atlas, Petavius, Aristillus, etc., to mention only a few, first photographed at short intervals throughout a lunation, then re-photographed during subsequent lunations under conditions of phase and libration approximating as closely as possible to the original set of negatives. A careful scrutiny and comparison of such a collection should yield more conclusive information regarding any suspected periodic or non-periodic changes than many years of assiduous personal observation.

"Holton," The Serpentine N., Blundellsands, Liverpool, August 27, 1934.

# J. Ernest G. Yalden
## (1870-1937)

*By* DAVID B. PICKERING

At noon one day in the early spring of 1919, a tall, angular man with a pointed beard and twinkling eyes wandered into my New York office and told me that he had a 3-inch telescope and wanted to know what to do with it. I told him. In 1925 he became President of the American Association of Variable Star Observers.

This man was James Ernest Grant Yalden. He died from a heart attack on February 22, 1937, at his home in Leonia, New Jersey, where he had lived for 36 years. Astronomers of Europe and America have lost a friend and co-worker whose place can never be filled. To the A.A.V.S.O., in particular, his going meant the loss of a genial companion—a generous and dependable adviser. So passed a remarkable individual, a type rarely to be found in our present-day society. His talents were many and diverse. His busy hours filled with the planning and execution of a great variety of undertakings, in all of which he excelled. Care and precision and a joyous enthusiasm marked each step of his progress in whatever he had in hand and never was he too busy—too bound to his task—to stop and lend a helping hand to others. To the very day of his death he was immersed in a host of interesting activities.

Born in the London suburb of Brixton on February 6, 1870, Ernest Yalden was descended from a family prominent since the time of William the Conqueror. Geoffrey Yalden, High Sheriff of Winchester in the 12th century, was his ancestor and three of his forebears were mayors of Winchester, while the present mayor is a cousin. His parents were James Yalden and Emma Churchyard Yalden. His father was commissioned by the city of Newark, New Jersey, in 1866, to organize its accounting system and later he organized Certified Public Accounting in this country.

Ernest Yalden came to the United States as a boy and attended the Riverside Academy at Poughkeepsie, New York, later entering New York University. He was graduated in 1893 as a Civil Engineer. On May 30, 1895, he married Margaret Lyon, whose brother, T. Littleton Lyon, is Professor of Agronomy at Cornell University. Mrs. Yalden survives him. For some years after leaving college Mr. Yalden was with the Carnegie Steel Co. of Pittsburgh, but in 1904 his advice was sought by the late Baron de Hirsch in connection with the establishment of a trade school in New York City. Mr. Yalden became the first Superintendent of the new institution, retaining the position for over a quarter of a century, during which he made notable contributions to administration methods. The school has graduated many men who have become famous in the field of building design and construction.

Ernest Yalden loved the out-door world and was equally at home on

the water or in the woods. He was as expert in making a camp as in handling a boat and he was ever striving to find a better way to do things. As a young man he spent several seasons in the Adirondacks with the famous American artist Winslow Homer, Yalden keeping camp while the older man painted. The "Yalden Tent" is still being sold by dealers in camp equipment. His love of the sea early invited the study of navigation and he would tell with pride how he had once piloted a great steamer from New York to Bermuda by dead reckoning alone. During the Great War, Yalden trained men to be navigators for the Merchant Marine, at the Government Station on Staten Island. He had, in his time, built many small craft from canoes to sea-going yawls. One of the latter was made famous by Alfred Loomis in his book, "The Voyage of the Hippocampus."

Mr. Yalden was the founder of the Mineralogy Club of New York and of the Whetstone Club. The latter was a local group of noted men who met to discuss their various hobbies. Incidentally Ernest Yalden built the first Graflex camera ever used in the United States.

To all his other accomplishments Mr. Yalden added the study of music and there was a time when he organized and conducted an orchestra in Leonia, arranging the scores for the various instruments and himself playing the clarinet.

Mr. Yalden was a recognized authority on sun-dialing and has published a monograph on the subject for the Museum of Industrial Arts in New York. Perhaps his chief work in this line is the splendid dial soon to be unveiled, which he was commissioned to build for the Marine Biological Laboratory at Woods Hole, Massachusetts. This consists of an ornate stone shaft eleven feet high, on which are five separate dials. Another commission, which, unfortunately, he did not live to complete, was for a sun-dial to be placed before Lowell House in Cambridge, Massachusetts.

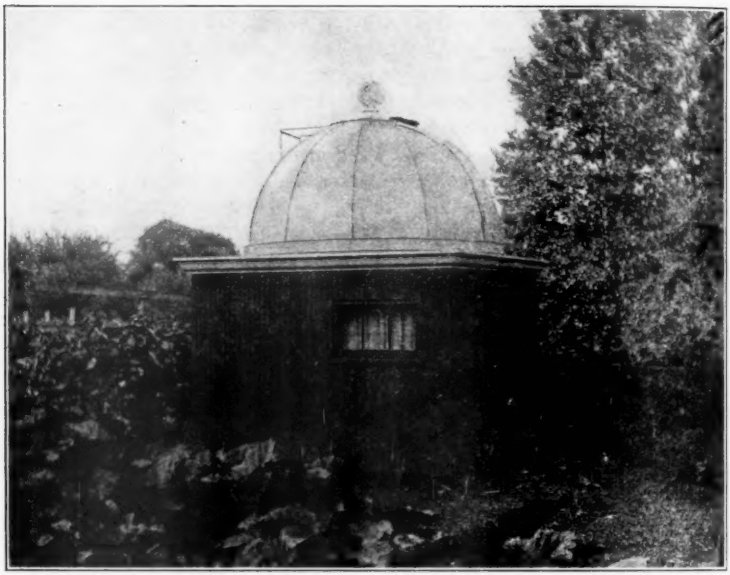
It was a fortunate thing for the A.A.V.S.O. that this remarkable man appealed to that organization when his fancy turned toward astronomy. He was a fine draftsman, and the writer solicited his aid in the making of master charts for variable star observation. Mr. Yalden's mathematical knowledge and his experience in the field of mechanics well fitted him for the position of Chairman of the Committee on Lunar Occultations, a post that he held for many years and brought to such a state of efficiency that Professor Ernest W. Brown once remarked that the A.A.V.S.O. became his chief source of data supply. Mr. Yalden was also chief adviser for the A.A.V.S.O. on observatory construction, and the telescope houses, large and small, of many of our members were built from his careful and precise plans. There was seldom a meeting of the Association whereat Yalden failed to present some new gadget, scheme, or device to facilitate our observational work. He was an inventive genius, but unlike most of that class, he brought his dreams to a practical and workable conclusion. The spring meeting of the A.A.V.S.O. was held at Mr. Yalden's home in Leonia, on May 25, 1925, during his

administration as President.

Mr. Yalden had gradually acquired an important library of rare and standard books on astronomy, mathematics, and mechanics and these, as well as his 4-inch Clark telescope and other astronomical equipment he has left to the A.A.V.S.O.

Mr. Yalden was a Fellow of the Royal Astronomical Society and of the American Association for the Advancement of Science, and a member of the American Astronomical Society.

Each autumn Ernest Yalden and I would motor together to Cambridge for the fall meeting of the A.A.V.S.O. We would stop at Nor-



OBSERVATORY BUILT BY MR. YALDEN AT HIS HOME IN LEONIA, N. J.

wich, Connecticut, and pick up Tyler Olcott, and we three would have a merry time together.

Last October Ernest and I went alone—for Tyler wasn't here to join us.

Never were the autumn colors of New England lovelier—never was that dear companion in a more congenial mood.

Though future meetings will seem strange without his familiar presence, he will live and carry on in the heritage he has left us. By his example we have learned that patience and thoroughness bring skill and success; that doing things for yourself brings independence; that, loving life, we should learn how best to use it.

EAST ORANGE, NEW JERSEY, MAY 9, 1937.

# An Unusual Auroral Display

By N. T. BOBROVNIKOFF

At about 8:30 E.S.T., April 27, 1937, a fine aurora was noticed by me on the northern horizon in Delaware, Ohio. There were low clouds in the north and northwest but otherwise the sky was clear. The aurora consisted of a low arch, which could not be seen distinctly on account of the clouds, and streamers showing their usual pulsation and motion from east to west. There was nothing especially remarkable about this aurora except perhaps its color which was distinctly reddish. Although auroras are seldom seen in our latitude, there would be no reason to describe this phenomenon in detail if it did not lead to another most remarkable display.

By 9:00 P.M. the aurora in the north apparently died out. The region from Polaris to the northern horizon was in clouds, but no particular illumination could be seen in the spaces between broken clouds. At this moment I noticed a strong narrow ray rising from the eastern horizon from a point some 5° south of the true east. The origin of the ray on the horizon could not be seen because of clouds. The ray, about 1° wide, spread in a few minutes across the sky, so that its center line was passing through δ Leonis a few degrees south of the zenith, and its western end through δ Geminorum. The western end was not sharp but was split into several branches apparently issuing from δ Geminorum and changing their position from time to time. The whole length of the ray was at least 150°.

The brightness of the ray was practically uniform, but somewhat greater near δ Leonis, probably because of atmospheric absorption in lower parts. Near the zenith the brightness was estimated by me to be about twice the brightness of the Milky Way in the Sagittarius cloud, but it may have been brighter as the sky was hazy and it was somewhat foggy. The color of the ray seemed to me perfectly white. The phenomenon lasted until 9:15 without noticeable change. At this moment I noticed that some 20° above the eastern horizon the ray terminated abruptly. I thought I saw the real eastern end of the ray but this was not so. I noticed soon that at the place mentioned there was simply a break in the intensity, the ray farther down toward the eastern horizon being much fainter. In two or three minutes the difference between these two parts of the ray nearly disappeared and the ray again regained its uniform brightness.

While I was watching these developments, the middle portion of the ray around δ Leonis suddenly burst into violent activity. Many sharp streamers seemed to issue from this star, following one another in their apparent motion from east through north to west. The streamers were about 10° long when east or west, but toward north they were shorter,

some 5°, apparently the effect of foreshortening. There were no streamers of this kind on the south side of the main ray. The region around δ Leonis was rapidly changing its shape, now becoming narrow (½°), now wide (2°), and twisting in a most complicated fashion. Almost simultaneously with this there seemed to be a violent motion of masses from δ Leonis west, along the main ray, and on its northern boundary, parallel to it. The character of the motion can best be described by globes of light, some 1° in diameter moving about 1° per second for a distance of 10° from δ Leonis west toward δ Geminorum and gradually fading out. This phase of the auroral activity lasted not more than two minutes. At first I could not believe my eyes, but the motion was too evident to entertain any further doubts. Several people watching this phenomenon with me confirmed my impression. Pretty soon the activity in the ray ceased and it resumed its former appearance. At this time it seemed to me that all across the sky, south as well as north, there were faint streaks of light running perpendicular to the ray. At one time a fainter ray parallel to the main ray began to form to the south, but soon disappeared.

By 9:30 heavy clouds came from the west completely obscuring the sky for half an hour, except for a break in the east at about 9:40. At that time the eastern part of the ray was still in its former place. The phenomenon lasted therefore at least 40 minutes during which time it did not appreciably change its position among the stars. An hour later the clouds broke up, but the moon was already above the horizon, and there was no evidence of the ray, or of any aurora in the north.

Such auroral rays are seldom observed. Probably the most remarkable one was seen on August 21, 1903, from various parts of the country between Maine and Iowa (Pop. Ast., Vol. 11, 1903, several descriptions; Barnard, *Ap.J.*, Vol 31, 210, 1910) giving evidence of the great height of such phenomena. According to Barnard (Williams Bay, Wisconsin) the ray of 1903 rose from the western horizon during an auroral display, was 80° long, and lasted 15 minutes. According to F. Campbell (Pop. Ast., Vol. 11, 484, 1903), however, the ray (northern New York state) rose from the eastern horizon, spreading toward the west. I could not find any description of unusual activity along this ray, but I do not doubt a careful search through records of aurorae would reveal similar observations. Formation of balls of light apparently moving along the streamers of ordinary aurorae has been observed many times before.

I have myself seen several such rays at various times, but they were quite faint and they never showed any activity. However, I thought it would be worth while to mention this interesting phenomenon as the sun-spot activity is increasing and, judging from the size of recent spots, promises to be higher than during the recent periods of sun-spot maxima. In fact a large group of spots was near the central meridian of the sun at the time of the aurora. I cannot but think of comets' tails in this

connection. Various phenomena in cometary tails described loosely as coruscations, scintillation, flickering, etc., are generally, but unjustifiably, regarded as optical illusion and that in spite of a very considerable volume of evidence to the contrary. The auroral displays have many features in common with the tails of comets, which considering the mode of excitation of cometary material is not surprising. In the present connection I want to mention the observation of Comas Solà (*A.N.*, Vol. 185, 75, 1910) of Halley's Comet in which he described globes of light constantly issuing from the nucleus and moving along the axis of the tail.

It is impossible to decide whether the motion of the luminous globes in aurora (as well as in comets) is actually transference of matter. In spite of a very definite impression to this effect, I think it was rather transference of luminescence. The velocity, however, assuming the height of the aurora to be 100 km would be only of the order of 2 km/sec.

PERKINS OBSERVATORY, DELAWARE, OHIO, APRIL 29, 1937.

# Fragmentary Notes on Astronomy in Japan

By YASUAKI IBA

[*Continued from page 252, Vol* **42**, *(May, 1934). It was there stated that the original form of the "notes" had been changed only to the extent of attempting to secure clarity of statement. The style of the author has been preserved wherever it is not likely to lead to misunderstanding.*]

## CIVILIZATION AND MEDIEVAL SCIENCES

Before dealing with Astronomy and its correlated sciences in the medieval stage, it is necessary to comment on the civilization and sciences distinctly characteristic of this country. In short, it may be said that the nation had well assimilated and always Japanized all sciences that crept into the country, from China and Korea, artistic, medical, philosophical, religious, architectural, and industrial; and in all cases changes ensued through improvements of its own. Notwithstanding in the ancient stage it was empirical and not theoretical.

It is an admitted fact that the intercourse with China by Buddhist priests and politicians was rather frequent, and consequent influence should be considered from civilization point of view.

Therefore the advent of theoretical science was really epoch-making in the medieval era, and to determine whence it came is a matter of further research.

The gradual advancement in nautical knowledge, accompanied by the new opening up of sea routes, had a great influence in all countries in

the East, giving impetus to the dormant and empirical science.

The astronomy which was then rather degraded into Astrology had met with evolution, and was placed on its proper track.

The first advent of European vessel had taken place in 1530 when rifle was presented to the Fuedal Lord of Bungo. (Rifle was known in Japan in thirteenth century at the time of the unsuccessful invasion by Mongols.)

The overseas intercourse with Europeans culminated in the last decade of Sixteenth Century, during which the nation came in contact with Occidental civilization and particularly a great stride was made in medical, military, and industrial sciences.—Note: Christian Church in Kioto was sanctioned to acquire extensive estates for plantation of medical drugs (Variety exceeding 3000 in all) at the foot of Mt. Ibuki which still exist in the present days, rendering a good service for the research of botanists.—Under Iyeyasu Tokugawa's administration, in 1612 more than 80 foreign vessels entered Japanese Ports (inclusive of those from China). In these days Japanese merchantmen crossed the expanse of Pacific Ocean and visited Mexican Ports and they were ubiquitous all around Asiatic Seas.

Thus scientific civilization advanced at an astounding rate in Sixteenth century. Shortly after the Christian Rebellion in Amakusa, however, the overseas intercourse was cut off by the injunction issued by Tokugawa Shogunate, excepting a limited trade with Holland and China.

This was quite detrimental to the development of growing sciences, and as a consequence in the subsequent three centuries scientific evolution could not be any more than with the rate of arithmetical progression.

When Lord Yoshimune Tokugawa occupied the post of the Eighth Shogun, however, scientific activity revived in all lines. He was a refined scholar himself and this accounts for the subsequent removal of prohibition act on the import of foreign literatures. A special mention must be made of the fact that he was a great astronomer, and his biographical review will be given minutely in later chapter.

N. B.—It was the Third Shogun, Iyemitsu Tokugawa, who prohibited the import of foreign books in 1630. The act was abolished in 1720.

Of the import of Chinese literatures, thirty eight varieties were restricted by the order issued in 1688 and 21 related chiefly to scientific works.

The first Astronomer who had adopted Occidental School and published its theory was Kichizaemon Hayashi, 2 years prior to the Christian Rebellion in Amakusa (Kiushu Island). Unluckily he was arrested, suspected of being a rebel, and died in the prison in 1646. His pupil Yoshinobu Kobayashi, who also spent a few years in prison, had propagated mathematical theory, and to him merit must be attributed in giving a rise to reformation of Senmei Calendar, together with Santetsu

Yasui whose unperishable contribution toward the Astronomical science will be dealt with later.

### Revival in Glass Industry

The introduction of glass-ware takes its origin as far back as the 6th Century when Buddhism had become to be rife, and yet the art of glass making seems to have fallen into abeyance in the course of time. According to "Nihon Bunkashi Nenpyo" (Annals For The Civilization In Japan) it was in 1570 that European tuitioned the art of glass-making in Nagasaki and a rapid stride was witnessed in consequence.

Thus lenses could be manufactured locally in later stage.

### Record of Spring-driven Clock

In the days of dim distance the time-piece employed was water-clock (sand glass and sun-dial, also), and so far as data in hands go the oldest spring-driven clock is that which was made by Seishitsu Fukada, of Mino Province, in sixteen thirties. He presented it to his Lord who domiciled in Nagoya and same was dedicated to Iyemitsu Tokugawa, the Third Shogun who was the tyrant in the way of scientific development.

N. B.—In Tokio Museum of Science varieties of clocks can be seen.

### Consolidation of Mathematics

It is much regretted that the mathematics which Kichizaemon Hayashi and his follower Yoshinobu Kobayashi tuitioned to the contemporaneous was Occidental for vernacular remains still in mystery. In later stage whilst astronomy had progressed to an astounding elevation it must be noted that the mathematics employed were totally Japanese. Practically speaking there seems to be no trace of Occidental mathematics being taught ere Kohhei Kanda, Professor in mathematics in Kaiseisho (University) in 1863.

N. B.—Concerning Japanese Mathematics, refer to Dr. Yoshio Mikami's paper.

No particular mention can be given in the mathematical progress until the last decade of Sixteenth Century, when Kanbei Mohri, a vassal of Hideyoshi Toyotomi, a grand hero of the time, went to Ming (the country then established in China) where he received mathematical education. Upon his return he found that the lineage of his Lord was completely exterminated and supplanted by Iyeyasu Tokugawa who shifted administrative offices to Yedo (present Tokio) and went thither where he gave private tuition to his pupils. His work "Kijo Ranpoh" is the first text book in Mathematics.

His pupil Yoshitane Takahara was later succeeded by Kohwa Seki who was born in the same year as Isaac Newton and had consolidated rudiments of Japanese mathematics, having completed his theory "Kigen Seiho."

Furthermore he devoted himself in the mathematical research

throughout his life-time and consumated a good deal of new theories, among which: "Endan Yakujitsu," "Senkan Shosa Kakujitsu," "Tekijinho," "Kohai Ritsuen" are said to be of great importance. It is very noteworthy that Kohwa Seki independently consumated the theory of Fluxional and Infinitestimal Anaylsis, prior to Newton and Leibnitz.

Later there came forth numbers of able mathematicians in his wake, such as:

Yoshita Kurushima who discovered theory called "Heiho Reiyakugaku," "Chikusakuhitsu"; Chokuen Yasujima who discovered theory called "Enchu Sakkyojitsu," "Kwanen Daen," "Seisujitsu"; Nei Wada who discovered theory called "Su Kyokugenho," "Hisenho."

### The Jokyo Calendar Reformation

As described in the foregoing chapter the ancient calendar that was in use till 692 was abolished and supplanted by Genka Calendar based on Chinese principle. The enactment did not last long owing to its proper defect found in observation, and in 697, in consequence of reformation by the hand of contemporaneous astronomers, Giho Calendar went into life. This was found to be defective in the course of 66 years and again had to be succeeded by Taiyen Calendar that was used for 93 years, and which then was found to be 17 Sections (24 hours = 100 Sections) accelerated. Upon seeing this discrepancy Manomaro Ohkasuga, The Astronomer Royal, showed the necessity of reformation and new calendar went into life, which was designated "Goki Reki." This was ephemeral, for within the course of 5 years discrepancy arose to 10 Sections and in 862 through another reformation Senmei Calendar was promulgated by the Imperial Ordinance of Seiwa Tenno.

Since then eight centuries had elapsed without any change, partly due to stagnancy and desuetude in astronomy and consecutive dilapidation by internal warfares; during which calendar variation was constant, though insignificant, and in the early Tokugawa Stage error was ascertained to be 1 day and 95 Sections.

Such being the case it was impossible to compute eclipses and the government of the time could not be indifferent any longer and, to scrutinize the case, Gentei Okai and Santetsu Yasui were formally commissioned by Masauki Hoshina, and yet for some reasons the work was suspended. In 1683 (*i.e.* on 1st 11th Moon) there occurred no Solar Eclipse in accordance with the almanac, and as this was predicted by a mathematical astronomer* of Nagasaki aforehand, he had won public acclamation. Hereupon, Santetsu Yasui urged the Government to appreciate the necessity of calendar reformation.

The Astronomical affairs, by traditional usage, were handled in Kioto, therefore Tokugawa Shogunate Government at last transferred same thereto.

Upon the call of the nominal Astronomer Royal, Santetsu Yasui vis-

*Yoshinobu Kobayashi.

ited Kioto and consultation ensued, in which he insisted total abolition of Chinese system and to reform under vernacular contrivance, and yet it was not accepted by the conservatives. The result was quite contrary to his scheme, and "Daitoh Reki" of Ming (Calendar of Ming—China) was officially adopted in 1st Moon 1684. Santetsu Yasui was however very persistent, and presented admonitory letters thrice to the Imperial Court, which eventually had borne fruit and Astronomer Royal yielded to confirm Santetsu Yasui's theory by observation. Every point that he insisted was proved to be of great accuracy and this had given a rise to the successive reformation in the same year, rendering actual existence of "Daitoh Reki" 10 months and the new calendar thus adopted was called "Jokyo Reki."

### The Short Memo on Astronomer Santetsu Yasui

From the foregoing chapter a rough sketch may be had of his merits and it will be worth while to describe his career in a short memo.

He entered as an apprentice to the School that was under the management of Sanchi Honinboh and in due course distinguished himself as the renowned player of "GO."

As for his astronomical talents he received tuition by Shoo Ikeda, a prominent mathematician of the time, who studied contemporaneous calendar precisely from mathematical standpoints, and detection of defect in the preceding calendar was rendered possible.

He was the first astronomer employed by the Tokugawa Shogunate Government, and after official promotion to the new post he changed his name as Shunkai Shibukawa. Furthermore he compiled star atlas in which he added 321 stars anew to that which then existed, and so far is believed to be the first compiler in this line. *On dit* his star atlas is owned by the Public School at Ashikaga, a town within reach of 2 hours travelling from Tokio.

### Biographical Reviews of Astronomers

Nyoken Nishikawa was a petty official in Nagasaki (His mission was a silk inspector). Then import of silk from China was rife and later he entered scientific life. His antecedents are not much known save the fact that he got tuition from Sohju Nanbu a scholar from Kioto. At any rate he was ranked in the foremost among the contemporaneous scholars, and in his 71 years had enjoyed a patronage of the Eighth Shogun Yoshimune Tokugawa.

Monographs edited by him amount to a good number, of which the following had a wide circulation:

Tenkei Wakumon ..... 3 Vol.
(Most popular astronomical text book of the time)
Tenmon Seiyo ..... 8 Vol.
Tenmon Giron ..... 2 Vol.
Kyodo Rekidan ..... 3 Vol.

Gusho Rekisho Zukai ..... 2 Vol.
Ryogishusetsu ..... 7 Vol.
Etc.—(In addition a few more books relating to astronomy)

The first named was of Chinese origin and in it geocentric theory was taken up.

Yoshimune Tokugawa, the Eighth Shogun, was as previously described a scholar with far-reaching thought. Whilst in the political life, every leisure he had was employed in the research of sciences, especially in Astronomical Work.

Under such circumstances he was benefactor in the renaissance which produced men of great scientific abilities in his stage.

Long before he had formally established Astronomical Observatory in Kanda, Yedo (present Tokio), he erected a small observatory of his own in the garden within the precinct of his castle and let his valets to observe transit of the sun, and in due course they attained observational talents. Katahiro Tatebe, his astronomer who occupied later the post as the Director in the Tokugawa Government Observatory, seemed to have engaged in daily observation. Upon receipt of report from Katahiro Tatebe that the instrument then installed was not adequate for the purpose, incurring harm on-to the eyes of the observer, he contrived himself to cut the slit in such part of the house as to sight the image of the sun, and to insert double-cross lines in the eyepiece of a telescope properly aligned; and await the sun to traverse the double-crossed lines at the moment time-piece signals the noon. Shortly afterward the occupants were startled to see by chance the similar cross wire in the eyepiece of the refractor dedicated to The Shogun from Dutch Government.

Through logical inference the writer wishes to take it for the initiation of transit observation. Another invention worth mentioning was the construction of dome in an original way.

It is said that the main frame was of iron, covered with leather thickly lacquered and telescope installed therein, and prevented same from being spoiled by the dews and rains.

The data in the writer's hand do not clearly mention the year in which this was completed, but it was in the last quarter of 17th Century. His observational work was not confined to Astronomy, and rainfall rate was surveyed and recorded in his private observatory at first and later in two other places, *viz.*, Shizuoka and Nagasaki. Hence at the time of great inundation that took place during his administration he could foresee it and its possible damages from his own daily records.

Baiyen Miura was very capable astronomer and born in Bungo Province Kiushu Island in 1723, and according to meager data relating his antecedents he entered astronomical life in his twenties. He educated himself without taking private tutor, and yet that he entertained the heliocentric theory by practical observation really deserves admiration.

*On dit* he had interviewed with Goritsu Asada, whose biographical

sketch will follow in the next column, with aim to get the corroboration of his theory; however, even with his unrivalled erudition G. Asada could not verify it at that time.

Afterward in a course of conversation with Yasunojo Matsumura he heard heliocentric theory from him and in that consequence in his later monograph "Kizanroku" he wrote as under:

"Theory discovered within past 100 years in Europe is that the sun never moves and the earth is not stationary. In details the sun is stationary and all objects outside of the sun revolve around the sun."

Whether Yasunojo Matsumura's heliocentric theory was from his own initiation or through perusal of foreign literature can not be discerned.

### The Horeki Calendar Reformation

In 1745 a new Astro Observatory was erected by The Eighth Shogun, Yoshimune Tokugawa, for which Director Katahiro Tatebe was appointed (To this Observatory Yoshimune Tokugawa's instruments were transferred) and the son of Nyoken Nishikawa, Chujiro Nishikawa (Pen Name Seikyu) as his assistant. In addition 2 more astronomers were promoted to be associate-observers, *viz.*, Yazayemon Yamaji—Mathematician and Calendar Expert—and Murayemon Asai. The Director was the authority in mathematics and edited more than a dozen books. The first commission given to this staff was to detect the error and correct the Jokyo calendar. Three years after the receipt of this command they succeeded in the compilation of the new calendar with more precision. At the injunction of the Eighth Shogun, C. Nishikawa went to Kioto and the testing experiments lasted 3 years by the incompetent Royal Astronomer, after which it was ascertained that error observed was 6 Sections 78 Minutes late. On this account Jokyo Calendar was put to an end and replaced by new one. This was 3 years after the death of Yoshimune Tokugawa, the heroic Eighth Shogun.—(Refer Cal. Ref. Column.)

The calendar thus reformed was named Horeki Calendar and was in life for subsequent 44 years.

### Kansei Calendar Reformation and Astronomer Goritsu Asada

There occurred error 3 Section (fast) in the course of 44 years operation of Horeki Calendar and Sakuzayemon Takahashi then the Assistant Superintendent, stationed in Osaka Castle and who was Astronomer himself, made a proposition that reformation was imminent. Unfortunately, however, there was no adequate expert in the Astro' Obs in Tokio so that his tutor Goritsu Asada was recommended by him. Nevertheless G. Asada forfeited promotion and S. Takahashi went to Tokio (Called "Yedo") with Gorobei Juichiya (later changed name to Daigyo Hazama) and engaged in reformation work which took 3 years and new Kansei Calendar was promulgated in 1797.

Goritsu Asada referred to was 2nd son of Keisai Ayabe (born in

Bungo, Kiushu Island, in 1734). His constitutional inquisitiveness led him into Medical and Astronomical study and it is noteworthy that when he was 20 years of age, despite of no notice in the Horeki almanac for 1754, he prophesised in the preceding year that on 1st 9th Moon there would be total solar eclipse, and as it was exactly endorsed he made his mark as a great asronomer. Once he had opportunity of visiting Yedo (Tokio) following his Feudal Lord, and it seems to be the case that having seen the Astronomical Observatory during his stay there he resolved to specialize in Astronomy. On his return to the native place he desired to retire from medical service but in vain. Thereupon he had no option but to take refuge and he achieved it with success and domiciled in Osaka where he lived by his profession—Doctor. (In his 28th year.) There he could devote himself in the study of heavenly science and observed celestial phenomena for full 9 years with the telescope that he made himself. (Regarding Historical review of Telescope making refer later chapter.) Hearing his unique reputation, all Feudal Lords rushed for him in an attempt to employ him, all of which were rebuffed and he continued his research. At last he had come to entertain doubt on geocentric theory and became supporter of Baiyen Miura the originator of Copernican Theory in Japan.

More than 10 years later an Occidental Astronomical Book written in Chinese was imported, in which coincidence was noted. His former name was Goritsu Ayabe and changed it after refuge. According to the chronicle he inaugurated two theories called "Shocho" and "Kiushoku" contents of which are not traced so far, which is sincere regret. His energetical activity was put to an end in 1799 with his death in Osaka. The inscription of his memorial monument edited by Shoyen Nakai reveals that his research was independent from the inception.

### The Theory of Laplace

In 1802 Ryuho Nakano, a scientist in Nagasaki who compiled the book under the nomenclature of "Rekisho Shinsho," dealt with a treatise in its Vol. 3 and named it "Konton Bunpan Zuye" which miraculously coincided with the theory established in 1796 by Laplace.

The influx of a new, foreign theory via Holland or from the country more than 10,000 miles distant under the contemporaneous communication cannot be deemed possible within a short interval of 6 years, hence the inference that it emanated from his own initiative may be acceptable. On the other hand in consideration of georg' [geographic] situation of Nagasaki which was the only entrance of foreign civilization at that time it might have been an imitation. This point still remains in doubt.

### Astronomers Brought Up by Goritsu Asada

Of all disciples brought up by Goritsu Asada there were three who distinguished themselves as the transcendent Astronomers in his wake, *viz.*, Sakuzayemon Takahashi, Gorobei Juichiya, and Bantoh Yamagata.

The first named who was extraordinarily promoted to the Director of

Astro Obs. of Tokugawa Shogunate Government in recognition of his deed in the compilation of Kansei Calendar from his former, minor position in Osaka, changed his name under the style of Tohko Takahashi. Tadataka Inoh, who became the great geodetic expert, having completed the most accurate maps of Japan, was tuitioned by him.

In his juvenile stage Tohko Takahashi was used to face monetary stringency, and the big date-plum tree then existing in his garden was one of the sources of revenue, hence in time of crop it was customary to keep vigilance all night for pilferage.

One day he found, to his astonishment, on his return from the office that it was cut down to the ground and rebuked his wife, to which her reply was very affectionate, saying "Though destitute as it is, you have every qualification to become a great astronomer, so that with view to remove out the source of your anxiety and to let you devoting to the study without worry it was cut down by my hands, for which makeshift further curtailment of living expense would be made."

It seemed to have encouraged him spiritually and he was awarded with honorable distinction.

Gorobei Juichiya is better known in the name of Daigo Hazama which he called himself later.

He was sixth son of the proprietor of pawnshop in Osaka. When he was twelve he startled his neighbors, having made a celestial globe after imitation by his small hands. It was in his seventeenth year that he started mathematical study, and the doubt which he had come to entertain through the perusal of Astronomical book called "Rekisho Kohsei" —of Chinese Origin—had led him to the school of Goritsu Asada.

At one time Goritsu Asada devoted himself in the vigorous study on the problem of planetary revolution, which though partly solved in a course of time, theory was still in obscurity.*

Gorobei Juichiya having indulged in its research had at last consummated the hypothesis, to the astonishment of his tutor. His instinctive genius in mechanism had produced many useful astro instruments, of which "Joyo Kiugi"—interpreting literally it seems to be celestial globe with a device of fine adjustment—and "Sokushoku Teifungi"—Measuring apparatus for eclipses—were highly appreciated by the scientists of the time.

Furthermore he made telescope himself and detected a theory called "Koshi Shinsano Ho"—Inferring literally a new mode of observation? —(This last item extracted from the inscription on his memorial monument written by Issai Sotoh.)

As has been previously interpolated under the heading of Kansei Cal. Reformation, he was selected and went to Yedo (Tokio) with Tohko Takahashi in lieu of Goritsu Asada, and for his merit he was given privilege by the Government to rank with "Samurai Class" and also to erect

*According to Mr. R. Ohtani, ex-professor at Osaka Koko, he had completed theory similar to Kepler's Third Law.

his private Observatory, to which Refractor dedicated by Dutch Government was lent.

Later at the order of Tokugawa Government he engaged in the geodetic survey along the coasts and managed the Solar Eclipse Expedition to Nagasaki in 1802. After the death of Tohko Takahashi he was again summoned to Yedo and ordered to compile "European Calendar Text Book,"* in co-operation with Sakuzayemon Takahashi II. After six years' service he returned to Osaka and died there in his 61 years of age (in 1816).

Bantoh Yamagata was an employee in the firm of a Financier in Osaka with close connection with feudal lords in Tohoku Regions, and yet at night his time was for study under the tuition of Chikuzan Nakai, an erudite of the time who lived in his neighborhood, and in due course of time no one could cope with him in the alacrity with which he made progress, and later entered the private school of G. Asada with a burning aim at astronomer.

His work "Yumenoyo"—The Stage of Dream—which he published in 1820 was itself the Encyclopedia, consisted of Astronomy, Geography, History, Economics, Chinese Classics, and Religion, etc. In his dissertation on Astronomy he professedly insisted that the sun was itself a fixed star and minutely expounded the heliocentric hypothesis. Furthermore law of gravitation and theory of tide were fully treated.

In his treatise there is a paragraph in which he dealt with pros and cons of European and Oriental Calendars, and hypothetically insisted to make vernal equinox as New Year's Day, and died in 1821 at the age of 74.

*Translation of Lalande's work.

*(To be continued.)*

# The Revival of Popular Interest in Astronomy

By H. B. RUMRILL

The occupation of the astronomer has always held some share of popular regard. Tersely put by a noted modern authority, "Astronomy is essentially a popular science." Akin to search for hidden treasure, or the uncovering of long lost civilizations, is the exploration of the astronomical unknown.

Where comparatively few pay attention to the practical side of the subject, involving the accurate measurement of time and the calculations requisite for the navigation of sea and air, its physical phenomena have a fascination for an increasing clientele among the general public. This is partly due to the establishment of fine observatories equipped with instruments capable of disclosing the constitution of the stars, the secrets of the nebulae, and the scenery of the Moon and of some of our planetary neighbors.

Present-day interest is, however, not quite like that of nearly a hundred years ago, when it was possible for a clever writer to perpetrate the famous "Moon Hoax," now a scientific curiosity. An extraordinarily credulous public swallowed the story, "hook, line, and sinker"—for was it not graced with the renowned names of Sir John Herschel and Sir David Brewster? Nor was its vogue measured only by initial appearance in a reputable newspaper, having been in such demand as to necessitate reprinting a number of times in pamphlet and book form.

Yet gullibility still persists in the shape of exaggerated credulity, and would doubtless be again in evidence if some one were to deliberately aver that human life had been *seen* upon the nearer planets, although it is but fair to say that the spread of liberal education is lessening the probability of a repetition of any such astronomical hoax.

While the cultivation of the science beyond the curricula of the colleges and universities is a pursuit restricted by the limitations of individual liking, we have been learning that a great deal of its content is within everyone's capacity to understand and enjoy, without the admixture of mathematics.

For many years there has been a deeper and growing attention to the heavens, attested by the prominence given in the newspapers and magazines to each fresh discovery and important development, along with the achievements of the big telescopes in sounding the farther domains of space with the aid of the camera. Even the modern astrologers have profited as a sort of by-product, as witness the "predictions" and horoscopes appearing in the daily press. And we still have with us almanacs with a medical or agricultural background, whose charlatanry, in addition to a recital of astrological "phenomena," pretends to foretell the weather; but in the latter respect competition is apparent as they do not agree among themselves even in the same general locality.

As a more permanent response there have been published many books written in non-technical style, with a special appeal arising from the marvelous reproductions of photographs illustrating the more brilliant regions of the sky, as taken in the great reflectors at the leading observatories. The recent successful casting of the glass "blank" for the 200-inch telescope to be erected on Mount Palomar in Southern California, with the detailed story of the performance, the lengthy period required in the tedious annealing process, and its carefully slow transportation across the continent, has aroused the most unusual interest among the general public.

Anticipation of what this mammoth instrument will do, and of how it will excel all previous efforts to penetrate the cosmic deeps, will maintain the interest thus begun, so that we may in due course expect the press to "feature" its trial trips through outer space as front page news, with appropriate headlines.

Across the gap of historic time from the pre-Babylonian naming of the constellations in the northern hemisphere, to the comparatively new

designations given those in the far southern skies (a natural consequence of the absence of civilization below the equator)—with its bright oases of the accumulation of astronomical knowledge among the Phoenicians and the Greeks, as contrasted with the general relaxing of attention to the physical sciences during the dreary period of the Dark Ages—the gradual awakening to the realities of Astronomy on the part of the learned, in the wake of the Renaissance, resulted in more or less of popular interest, restricted at first, yet increasing in scope with the recession of illiteracy.

We must look to the Orient, principally to Mohammedan Asia, for the intellectual brightening that preserved whatever knowledge of the stars had been transmitted through earlier channels after the time of Hipparchus, the famous astronomer of the pre-Christian era. The Persians and the Arabs were true observers, leaving an indelible imprint on the "sands of time" for the benefit of posterity, and the names by which they knew the brighter stars have become classic, even though many have been corrupted from the original sources.

It is noteworthy that the names bestowed, as if by common consent, on the constellations and the stars were of a "familiar" character, indicative of popular interest, although confined mainly to the sky as a series of pictures, especially the panorama of the Zodiac, marking the pathway of the members of the Solar System, and acquaintance with which seems to extend to the remotest antiquity. There was, and is, more of genuine human interest in Sirius as the "dog star" than could possibly inhere in its astronomical designation of "Alpha Canis Majoris"; whilst the mythology associated with many of the northern star groups is assuredly more attractive to the lay mind than any cut-and-dried recital of their wondrous contents from a strictly astronomical point of view.

Of the maritime countries along the Mediterranean, to which the early navigators of the East had carried some of their astronomical lore, it is possible to conceive that, back of the impetus that resulted in the discovery of the "new world," there must have been considerable public interest in the connection between celestial and terrestial geography. In those times there were not a few makers of both classes of globes, and while the influence attributable thereto was doubtless quite limited, nothing short of an earnest purpose on the part of the intellectually inclined to look beyond the narrow confines of the then known world into the "terra incognita" of the geographers could have sustained the pioneer daring of Columbus and his kind.

The continuance of public attention to the exploration of sea and land during the Middle Ages could but naturally lead to the circumnavigation of the globe and to the incidental sighting of the constellations nearer the south pole—the latter an opportunity reserved largely to the Dutch, although additional constellation groups were afterward charted and named by the eminent French astronomer Lacaille, who spent some years in southern Africa to that end. Popular stellar nomenclature did

not, however, extend to the individual stars visible only in the southern latitudes, so that the residents of Australia and South Africa lack whatever incentive arises from that source in evoking popular esteem.

In the northern skies, where we have the familiar "North Star," or Polaris, definitely marking the north polar point with a constancy that will change only through the ages, its opposite, the south polar star—unnamed except in the Greek-Latin astronomical style "Sigma Octantis" (as well as by a prosaic catalogue number for observatory use)—can scarcely be perceived without instrumental assistance! On the other hand, we of the north miss the group of the Southern Cross, the mysterious "Magellanic Clouds," and much of the glory of the extensive constellation Argo, "the Ship."

During the last quarter of the eighteenth century and the earlier part of the nineteenth, when the civilized world was witnessing the progress of the Herschels in the exploration of the nearer levels of the Universe, consequent upon the building of the largest reflecting telescopes of the time, the enthusiasm engendered by their discoveries spread (especially in Europe) beyond the purview of the professional astronomers to many whose interest, thus elicited, led to a better appreciation of astronomical facts. There naturally ensued the construction of still larger telescopes by the English *amateurs* Lord Rosse and Lassell—the precursors of the more perfect instruments now scattered over the world—and employed in continuing the noble work begun by the Herschels. (The Rosse telescope has not been in service for a number of years, and that of Lassell was long since dismantled, its mirror "consigned to the crucible of the bell-founder.")

Sir William Herschel was typically one of those whose romantic career followed upon some casual peering at the "worlds of space" through a small telescope. Not unlike accidents of birth, those of chance sometimes find their mark, and astronomy has had a plenty of such windfalls. Forsaking the vocation of a musician, in which he was well accredited, the impulse thus acquired was destined to place him in the forefront with such astronomers as Copernicus, Tycho Brahe, Galileo, and Newton—truly among the immortals.

Undismayed by seemingly endless failures, that actually marked the road to success, Herschel kept at the casting, grinding, and polishing of telescope mirrors of brittle speculum metal (an alloy of copper, tin, and arsenic) in order that he might, with the invaluable aid of his sister Caroline, "mind the heavens" and—discover the planet Uranus, thus advancing the bounds of the Solar System a thousand million miles, and laying the foundation for the later mathematical discovery of its yet more distant members, Neptune and Pluto, all existing within the *celestial incognita* of that System's relatively little apportionment of space.

Incidentally, in the middle of the last century, it fell to the honor of William Rutter Dawes, an English astronomer of exceptional attainments, who began his life work in an amateur capacity, to recognize the

ability—really the genius—of our own Alvan Clark, who abandoned the occupation of portrait painting to produce superior telescopes, which Dawes was the first to use abroad. Persevering, as Herschel did, against many obstacles, this artist mastered the nearly insuperable difficulties of grinding and polishing big lenses (themselves works of art in the highest sense) until he had perfected the splendid Lick and Yerkes telescopes, that after fifty years of usefulness are still unrivalled as instruments of the kind known as refractors. Possibly the results attained with those Clark lenses have, as much as any other single influence, made for the quickening of the popular regard for astronomy now in evidence.

Others were attracted similarly to the "oldest of the sciences": among them Burnham, a shorthand reporter of Chicago, who *after his daily routine in court* devoted himself to the observation and recording of double stars, discovering with a small telescope (made by Alvan Clark) hundreds of those objects that had eluded the scrutiny of contemporary observers using more powerful glasses; Barnard, a photographer of Nashville, whose photographs of the nebulae inaugurated the present era in that field; Brashear, a Pittsburgh millwright and pattern maker, whose enthusiasm for astronomy started with chance observations of the stars, and whose appreciation of the astronomer's requirements led to the fabrication of instruments of a perfection theretofore rare; and the able Simon Newcomb, almost entirely self-taught, who became the dean of the profession in America and the head of its Naval Observatory.

Mere hero worship is not involved in thus instancing these men of the past for their part in furthering the cause of science, for none sought notoriety, and their serious interest in astronomy had its origin in phases that carry popular appeal, although undoubtedly responding to some latent bent of mind.

A still larger number followed in the dedication of their efforts to the advancement of astronomy, of whom "honorable mention" should be made of the scholarly Princeton astronomer Young, whose labors in the field of solar physics ranked him second to none of his time; of Keeler, who demonstrated spectroscopically (with a Brashear instrument) the truth of Maxwell's theory of Saturn's ring system as a mass of discrete particles or meteorites—a problem in the very fairyland of mathematics and of physical astronomy; of Aitken, the Lick astronomer who successfully carried on the important work of Burnham in extending knowledge of the binary stars ("doubles" being so known when constituting distinct systems obeying the common law of gravitation); of Hale, inventor of the spectroheliograph, by which our conception of solar phenomena has been expanded beyond the ultima thule of the older astronomers; of Rowland, the Johns Hopkins physicist, whose exquisitely ruled "gratings" enabled the employment of the light analyzing properties of the spectroscope to a degree unthought of a generation before; of Langley, student of astrophysics and author of *The New As-*

*tronomy,* a book that greatly enhanced popular interest in the subject. The list is a lengthy one, including the names of many notable English, French, and other foreign astronomers, engaged in pushing back the frontiers of attainment in the science.

These modern pioneers have, in turn, been succeeded by another group of followers—a well-knit body of investigators in the great observatories, laboring unceasingly to glean additional facts and evidence of import to those who are yet to travel along these fascinating avenues of research, now broadening in a way that was just being sensed during the *infancy* of development fifty years ago. Especially since the commencement of the present century progress has not been limited to the professional ranks, but has been shared in by those whom the writer prefers to call non-professional, rather than amateur, observers, who give themselves to the work out of the highest motives, and are sometimes called into the former class through meritorious accomplishment.

As might be inferred from the citation of the name of Caroline Herschel, women astronomers have had a goodly share in unlocking the story of the heavens. Many have become distinguished for conspicuous ability along the lines of original research, among them Mary Somerville, Maria Mitchell, and Agnes M. Clerke, of a past generation, and the later Harvard workers, Mrs. Fleming, Miss Furness, and Miss Cannon.

The writer will ever remember with pleasure and gratitude a dear old clerical friend who, like so many of the clergy, particularly in England, have found time for attention to astronomy. For more than thirty years of a busy life he maintained a daily record of the phenomena of sun spots, just as did the German apothecary-astronomer Schwabe, whose observations enabled the deduction of the primary law of periodicity, that is, the alternate rise and fall in the number of spots during the well-known cycle of eleven years.

Non-professional activity in astronomy has of late years extended to the formidable task of grinding and polishing the mirrors used in reflecting telescopes of moderate size; emulating, it might be said, the earlier efforts of Sir William Herschel. Those who make a success of this arduous and delicate work are surely entitled to be welcomed into the fold of the astronomical elite, although abundant reward is found in the possession of instrumental means that will assist in reading the open book of the sky.

There have been periods when progress seems to have halted until rescued by some startling event such as the appearance of a great comet, or it may be a renascence resulting from the unheralded apparition of a "nova," or so-called new star, flaming out in some region of the sky that knew no bright stars before. It is not intended to convey the impression that there is any likelihood popular interest in astronomy can ever relapse into the almost hopeless state of the millennium of desuetude that unfortunately ensued upon the work of Ptolemy. There is too much to be learned, and the stars themselves will always present prob-

lems for solution. Who knows but that the next bright comet may be first seen by some humble observer with a small telescope?

Within recent memory are the circumstances surrounding the mathematical detection and visual discovery of the planet Pluto, earth-like in size, traversing a lonely orbit the completion of which, since it was computed, must await the astronomers of 250 years hence. What instruments will be at their disposal in the year 2187?

As of present bearing, it would be difficult to overestimate the influence of that discoverer of *galactic systems*—"island universes" visible only on the photographic plate, coursing through space at distances compared with which the Milky Way is but a next-door neighbor—Shapley, of Harvard, over the earnest ones ready to be enrolled among those who "love the stars too fondly to be fearful of the night."

In England these star gazers make up largely the membership of the British Astronomical Association, in this country that of the American Astronomical Society and the Astronomical Society of the Pacific, in the antipodes the New Zealand Astronomical Society, and in Philadelphia the Rittenhouse Astronomical Society, a local organization named after the ingenious mechanician-astronomer David Rittenhouse (a Colonial contemporary of Herschel), which began its existence fifty years ago as a small group of astronomy-lovers who met in each others' homes.

An English historian of astronomy, Sir George Cornewall Lewis, in alluding to it rather ironically as a "science of pure curiosity," was not far from the truth in thus dubbing it, for enlightened curiosity is unquestionably one of the motives that keep an ardent observer out of bed the better part of the night. Still, it must be admitted that courage was another requirement when our party observed the total eclipse of January, 1925, in sight of the "lordly Hudson" and the Shawangunk Mountains, with snow two feet deep and the thermometer twenty below!

After all, the stars are not "fixed." There is always something "going on" in the sky; the ever-changing planets and the Moon (even as a dead world) never become stale, and the ruling star of our own system—the Sun—is never quite the same from day to day, for processes of the most amazing kind are constantly at work there, illustrative of what is also taking place on other suns conventionally known as stars.

Among the leading factors in the increasingly popular regard for astronomy must be counted the wonderful imitation of the sky as seen in a planetarium, with its remarkably accurate delineation of the motions of the heavenly bodies. Another is the utility of the ordinary binocular in adding to the capaciy of the eyes in viewing the brilliants of the sky—and one's first sight of such a star group as the Pleiades through a good prism glass is bound to be a revelation, surpassable only by the picture made by its own light on the photographic plate, unveiling the astonishing nebulosity in which its stars are engulfed.

Aside, then, from the educational and esthetic elements that attract the growing number of the votaries of astronomy, there is the incentive

inseparable from all these things of the sky as they yield silent evidence of the continuity of Creation and the relationships existing throughout space, even to the most remote systems of universes within our instrumental ken. It is all gradually augmenting an extremely restricted stock of knowledge, and in gathering accretions thereto the "skies above with endless change" will continue to be attacked by a host of observers armed with instruments of all kinds and sizes, without fear that the pursuit need ever pall.

And the inquiring mind of the lover of astronomy, if ever in need of encouragement, will find it in those inspired lines of Kipling:

*Something hidden. Go and find it. Go and*
*look behind the Ranges—*
*Something lost behind the Ranges. Lost and*
*waiting for you. Go!*

---

# Life on the Moon

By W. H. PICKERING

The present title sounds rather visionary but I think we shall show before long that such evidence exists and is confirmed by a dozen or more observers. The confirmation which I wish to explain here consists of testing the actual life of plants of a rudimentary type when exposed to high and low temperatures. The great question that is to be solved is how plants can stand the great range of temperature that is to be found upon our satellite.

The test which I propose is to take, for instance, plants which are accustomed to a low temperature on the earth and shut them up in a box which is dark and expose them to a temperature of liquid air for an interval of twenty-four hours. At the end of that time the box will be opened and the plants taken out. They will then be allowed to change gradually to terrestrial conditions. It will be simple to change the liquid air for some other material. This experiment will represent to the best of our ability the conditions found upon the moon when this portion of our satellite is no longer exposed to the sun's rays.

It is proposed to try a similar experiment with hot air instead of cold and we shall thus get the range of temperature on the moon by actual measurement. It is an interesting fact that, although it is generally believed that the temperature on the moon when the sun is on the lunar meridian is very high, yet the lunar vegetation, as we call it, will flourish only between lunar latitude plus 50° and minus 50°. The temperature of the moon is too low to grow vegetation except in its torrid zone, and the polar regions are subject to barren conditions.

An entirely different kind of proof depends on the color change that we find on the moon itself. This matter was taken up many years ago

by the writer who showed that a portion of the floor of the crater Grimaldi, when the sun rose upon it, was grey, in a couple of days it took a faint greenish tint and during three or four days after that it again turned grey and remained so until sunset. The color change can only be detected by comparison with the floors of other craters. The craters selected for this comparison were really too small, but they were the only ones we could use since other suitable dark craters would not come into the field of view. One of them was called Billy and the other Kreuger. At the times indicated they were distinctly browner than Grimaldi. I think that the colors were really much as stated, but it is possible that Billy was reddish brown which made Grimaldi look green, or that Grimaldi was grey which made the floor of Billy look brown. The color change is exceedingly small for craters of the size of the two above used for comparison, and it is not an easy observation to make.

Another and more marked change occurs on the other limb of the moon between the craters Stevinus and Snellius. About an hour or two *before* the sun reaches the floor of Stevinus the floor itself begins to brighten and change color, and when the sun gets 5° higher the floor is distinctly reddish brown. By the time that the shadow reaches the other side of the floor, as the sun rises higher, the red color fades out. During these 5° the floor of Snellius has been totally black from shadow. The floor of Stevinus should also appear black since these two craters are close together, differing in longitude by only 2° and by about 3° latitude, so we see that they should have gone through exactly the same changes in color whereas Snellius never shows a particle of red but is always black when not illumined by the sun. The change in color of the floor of Grimaldi was confirmed by a dozen young men students under the charge of Mr. Harz, one of the older students and an expert on lunar craters. The changes in Stevinus have been confirmed by fully a score of persons who have viewed the crater at different times. We do not think that any of these changes can be due to mineral or geological causes. Those in Grimaldi are utterly different from those in Stevinus. The changes in red being apparently due to a different cause from the changes in green. In the case of Stevinus the color effect takes place very soon after the sunlight reaches the floor, but in the case of Grimaldi the change does not begin until two or three days after the sun reaches the crater floor.

Another difference which is strictly a case of geometry is that the duration of the color change of Stevinus is only 5° of longitude when the sun reaches the floor and the change is over. Since we have only 5° in which to observe, it is clear that not every appearance of the moon will show it. Since the distance travelled by the moon in 24 hours is 12° the change can only last at most five-twelfth's of 24 hours, and therefore it is only visible during that lunation.

I have not referred here to the ordinary lunar changes of small areas from bright to dark and then from dark to bright. These have been

treated elsewhere in my writings and are on a sufficiently large scale so that they can be clearly recorded by photography (See *H.A.*, **32**, part 2). Some years ago I remember seeing in a magazine article that some one exposed the germs of certain diseases to liquid air for some hours and found that they had survived.

It is to be hoped that some one with the necessary facilities of a large university will undertake the experiments described in the first portion of this article, thus giving us at length some accurate value of the temperatures at which vegetation will survive.

MANDEVILLE, JAMAICA, 1937 APRIL 21.

## Planet Notes for July and August, 1937

Note: All times, unless otherwise stated, are Central Standard Time.

The *Sun* in the interval from July 1 to August 31 will move eastward from $6^h\,38^m$ to $10^h\,35^m$ and southward from $+23°\ 10'$ to $+8°\ 53'$. Its path for this period will start in Gemini, extend through Cancer, and end in Leo, near the first magnitude star, Regulus. The effect of the southward motion of the sun in lessening the length of the days will be very noticeable. The earth will be farthest from the the sun for the year on July 5.

The phases of the *Moon* will occur as follows:

| | | | | |
|---|---|---|---|---|
| Last Quarter | July | 1 | at 7 | A.M. |
| New Moon | | 7 | " 10 | P.M. |
| First Quarter | | 15 | " 4 | A.M. |
| Full Moon | | 23 | " 7 | A.M. |
| Last Quarter | | 30 | " 1 | P.M. |
| New Moon | August | 6 | " 7 | A.M. |
| First Quarter | | 13 | " 8 | P.M. |
| Full Moon | | 21 | " 7 | P.M. |
| Last Quarter | | 28 | " 6 | P.M. |

The moon will be nearest the earth (perigee) on July 6 and on August 2, and farthest from the earth (apogee) on July 18 and on August 14.

*Mercury* at the beginning of the period will be a short distance west of the sun. It will be moving eastward more rapidly than the sun and will come to superior conjunction on July 8. It will continue to move east until it reaches its greatest eastern elongation on August 18. At this time Mercury will be a few degrees south of the sun but will be easily visible as an evening star near the western horizon at sunset. At the endof the period, Mercury will be too near the sun to be visible.

*Venus* throughout July will not change its position greatly with respect to the sun. It will, therefore, continue as a brilliant morning star. In August Venus will move eastward more rapidly than the sun and consequently it will not be so high at sunrise as in July, but will still be conspicuous because of its great brilliancy.

*Mars* will move eastward slightly less rapidly than the sun, and consequently its distance east of the sun will be lessened from about 8½ hours to 6 hours. Throughout this period, therefore, Mars will be well situated for early evening

observation and study. However, because it is more than twenty degrees south of the equator throughout the period, observers in the southern hemisphere will be most favored. Mars passed opposition on May 19. This was not one of the most favorable oppositions, as at its nearest point it was still some 48,000,000 miles distant.

*Jupiter* will be at opposition on July 15. This means that it will be near the meridian at midnight throughout these two months. It, like Mars, will be quite far south. Jupiter will be between the constellations Sagittarius and Capricornus. It will be an object of interest to amateurs with small telescopes because the ever-changing aspect of its satellites affords an interesting study.

*Saturn* will change its position very little with reference to the stars. Its net motion will be about one degree west and one degree south. The sun, however, will be moving away from it thus causing Saturn to rise earlier from night to night. At the end of the period it will rise soon after sunset. It will be in the constellation Pisces.

*Uranus* will be at quadrature, six hours west of the sun, on August 6. On and near this date it will, therefore, rise about midnight. Its position on August 1 will be $2^h\,45^m$, $+15°\,31'$, about eight degrees south of the Pleiades.

*Neptune* will still be visible in the west at sunset during the early part of July. It will then become lost in the rays of the sun. On August 1 its position will be $11^h\,14^m$, $+6°\,0'$, in the eastern part of Leo.

## Asteroid Notes

By HUGH S. RICE

### Ceres and Juno

Ceres is in the southwest corner of Aquarius during June and July. On June 8, it will be found about 3½ degrees south of the star 53 Aquarii. It then goes eastward, circling north of $\upsilon$ Aquarii, and on the last of July it is 1° west of 49 Aquarii. Its magnitude is 8 during the month of July. We expect in the next issue to give a chart of its course among the stars for August and September.

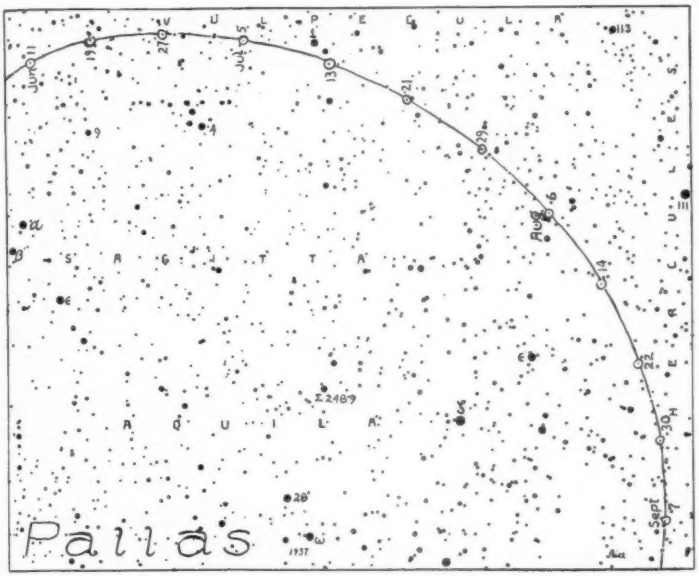
Juno is about 2° south of $o$ Virginis on June 13, with brightness of $10^M.3$. On August 1 it is 4° nearly north of $\gamma$ Virginis. It has proved practicable to locate any of these brighter asteroids by such approximate directions.

### Pallas

The chart published herewith shows the apparent path of the large planetoid, 2 Pallas, for the summer months in the Milky Way regions as marked on the diagram. In July the magnitude is 9.2 and it can therefore be just picked up with 2-inch aperture. Opposition takes place on July 10, when the distance from the earth is about 240,000,000 miles. As the chart indicates, the planet passes in close conjunction with many stars. The exact positions as given correspond to 7:00 P.M., E.S.T., of the days marked.

### Fainter Planets

We believe that among the fainter asteroids the two which are best for observation at this time are 15 Eunomia and 532 Herculina, whose ephemerides, as computed by the Astronomisches Rechen-Institut, are given below. Eunomia was discovered by de Gasparis at Naples on July 29, 1851. Since then, various com-




puters have worked on the calculation of the orbit of this asteroid. At one time, a variation of brightness was noticed. Professor E. C. Pickering determined the period as $0^d.1267$. The other planet, Herculina, was picked up in more recent times, April 20, 1904. It was one of Wolf's discoveries. According to Leuschner, it is the last asteroid discovered with mean opposition magnitude brighter than 10.0.

ASTEROID EPHEMERIDES. FOR $0^h$ G.C.T. EQUINOX 1925.0

| | 15 EUNOMIA $8^M.7$ | | | 532 HERCULINA $9^M.8$ | | |
|---|---|---|---|---|---|---|
| | α | δ | | α | δ | |
| | h m | ° ′ | | h m | ° ′ | |
| June 12 | 19 21.0 | —27 0 | June 20 | 19 34.0 | —19 40 | |
| 20 | 19 14.6 | —26 48 | 28 | 19 27.5 | —20 36 | |
| 28 | 19 6.9 | —26 33 | July 6 | 19 20.2 | —21 34 | |
| July 6 | 18 58.4 | —26 14 | 14 | 19 12.7 | —22 31 | |
| 14 | 18 49.7 | —25 51 | 22 | 19 5.4 | —23 25 | |
| 22 | 18 41.6 | —25 24 | 30 | 18 58.9 | —24 15 | |

Hayden Planetarium, American Museum of Natural History,
New York City, May 21, 1937.

## OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to

the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.

| Date 1937 | Star | Mag. | IMMERSION Greenwich C.T. | IMMERSION *a* | IMMERSION *b* | IMMERSION Angle E from N | EMERSION Greenwich C.T. | EMERSION *a* | EMERSION *b* | EMERSION Angle E from N |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | h m | m | m | ° | h m | m | m | ° |
| July 4 | δ Ari | 4.5 | 8 48.2 | +0.7 | +3.5 | 10 | 9 18.3 | —1.7 | —0.5 | 312 |
| 17 | Mars | —0.8 | 19 30.7 | +0.3 | —0.4 | 146 | 20 25.2 | —1.1 | +2.0 | 252 |
| 20 | 21 G.Sgr | 5.7 | 23 30.4 | —1.5 | +2.0 | 62 | 0 41.4 | —1.4 | +0.3 | 299 |
| 21 | 33 Sgr | 5.8 | 23 23.0 | —0.6 | +1.2 | 101 | 0 34.0 | —1.3 | +1.6 | 250 |
| 22 | ξ Sgr | 3.6 | 1 40.4 | —1.8 | +1.5 | 63 | 3 4.2 | —2.1 | +0.2 | 276 |
| 31 | 36 Ari | 6.5 | 3 53.6 | +0.4 | +1.3 | 75 | 4 44.4 | +0.2 | +1.4 | 250 |
| 31 | 40 Ari | 6.0 | 5 48.0 | +0.2 | +2.3 | 34 | 6 35.3 | —0.8 | +0.9 | 286 |
| Aug. 3 | Venus | —3.6 | 7 13.4 | —0.3 | —0.1 | 139 | 7 48.9 | +0.7 | +2.7 | 217 |
| 15 | δ Sco | 2.5 | 0 2.0 | —2.0 | —2.0 | 147 | 0 58.9 | —1.8 | +0.4 | 226 |
| 16 | 24 Oph | 5.6 | 3 0.8 | —1.1 | —0.7 | 70 | 4 14.4 | —0.9 | —1.6 | 277 |
| 19 | 266 B.Sgr | 6.1 | 5 17.5 | —0.7 | +0.2 | 45 | 6 23.7 | —1.0 | —1.4 | 270 |
| 20 | 31 B.Cap | 6.4 | 5 48.1 | —2.1 | —2.1 | 114 | 6 34.7 | +0.1 | +1.6 | 193 |
| 20 | 27 G.Cap | 6.2 | 7 35.7 | +0.1 | +1.0 | 22 | 8 21.2 | —0.7 | —2.3 | 289 |
| 30 | BD+21°918 | 6.3 | 6 50.3 | —0.2 | +1.6 | 77 | 7 51.7 | —0.8 | +1.0 | 274 |

OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| July 5 | 51 Tau | 5.6 | 9 53.3 | —0.2 | +1.2 | 92 | 10 48.2 | —0.2 | +1.7 | 243 |
| 13 | *e* Leo | 5.1 | 2 27.0 | .. | .. | 31 | 2 36.2 | .. | .. | 18 |
| 22 | ξ Sgr | 3.6 | 1 9.3 | —1.1 | +1.7 | 77 | 2 26.9 | —1.5 | +0.9 | 272 |
| 25 | $c^1$ Cap | 5.3 | 11 38.5 | .. | .. | 136 | 11 58.0 | .. | .. | 170 |
| 31 | 40 Ari | 6.0 | 5 51.1 | +0.7 | +2.5 | 18 | 6 22.2 | —0.4 | +0.3 | 306 |
| Aug. 14 | δ Sco | 2.5 | 23 41.4 | .. | .. | 175 | 0 9.5 | .. | .. | 211 |
| 16 | 24 Oph | 5.6 | 2 33.1 | —1.9 | +0.2 | 61 | 3 53.1 | —2.0 | —1.8 | 292 |
| 19 | 266 B.Sgr | 6.1 | 5 0.5 | —0.8 | +1.6 | 22 | 5 58.7 | —2.5 | —2.0 | 293 |
| 20 | 31 B.Cap | 6.4 | 5 8.9 | —2.2 | —0.2 | 88 | 6 23.8 | —1.0 | +0.8 | 218 |
| 20 | 27 G.Cap | 6.2 | 7 37.6 | .. | .. | 353 | 8 1.6 | .. | .. | 313 |
| 27 | 36 Ari | 6.5 | 10 34.5 | .. | .. | 142 | 11 2.5 | .. | .. | 181 |
| 28 | 22 H.$^3$Tau | 6.0 | 11 0.6 | .. | .. | 13 | 11 35.7 | .. | .. | 321 |
| 30 | BD+21°918 | 6.3 | 6 47.6 | +0.4 | +1.7 | 63 | 7 38.5 | —0.4 | +0.7 | 288 |

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| July 5 | 56 Tau | 5.3 | 10 27.8 | +0.7 | +1.8 | 41 | 11 7.3 | —0.2 | +0.4 | 296 |
| 25 | $c^1$ Cap | 5.3 | 10 42.2 | —2.2 | —0.5 | 88 | 11 51.0 | —0.7 | +1.4 | 207 |
| 31 | 45 Ari | 5.9 | 8 29.6 | —0.4 | +0.4 | 118 | 9 7.0 | +0.4 | +2.6 | 203 |
| Aug. 16 | 24 Oph | 5.6 | 1 20.7 | —2.3 | +1.3 | 78 | 2 50.3 | —2.3 | —0.5 | 296 |
| 20 | 31 B.Cap | 6.4 | 4 5.8 | —1.8 | +1.6 | 67 | 5 31.8 | —2.1 | +1.0 | 250 |
| 27 | 36 Ari | 6.5 | 9 22.2 | —1.7 | +0.8 | 99 | 10 24.2 | —0.9 | +2.6 | 215 |
| 27 | 40 Ari | 6.0 | 11 55.2 | —2.1 | +0.8 | 77 | 13 18.3 | —2.0 | +0.8 | 244 |

## Comet Notes

By G. VAN BIESBROECK

This month the recovery of two expected periodic comets has been announced:

PERIODIC COMET 1937 *d* (GRIGG-SKJELLERUP) was found by L. E. Cunningham in the following position on a photograph made by him with the 16-inch refractor at Oak Ridge (Massachusetts):

1937 April 30.06248 U.T. $\alpha = 6^h\,58^m\,59^s.98$ $\delta = +7°\,53'\,26''.8$

He described the comet as a faint coma 40″ in diameter and of total magnitude

13.4. This first observation indicates that the time of perihelion passage is May 23.1, only 0.6 day later than was predicted by Harris and Henderson who gave the ephemeris reproduced on p. 265. The ephemeris can now be corrected as follows (L. E. Cunningham):

| 1937 | α h m | δ ° ′ | Distance from sun | Distance from earth | Mag. |
|---|---|---|---|---|---|
| June 4 | 9 34.3 | +22 54 | 0.93 | 0.42 | 12.1 |
| 8 | 10 1.8 | 25 4 | 0.94 | 0.41 | 12.1 |
| 12 | 10 32.5 | 27 8 | 0.96 | 0.39 | 12.1 |
| 16 | 11 5.8 | 28 55 | 0.98 | 0.38 | 12.2 |
| 20 | 11 41.4 | 30 14 | 1.00 | 0.38 | 12.3 |

The comet remains an evening object in the constellation of Leo. The position will improve during June but not much change in brightness is expected. Looking back at the earlier plates taken of the field of this comet and knowing the correction of the ephemeris, the writer was able to locate the image of the comet on a plate taken at the Yerkes Observatory a month before Cunningham's discovery:

March 29.07022 U.T. $\alpha = 5^h\,48^m\,57^s.61$ $\delta = +0°\,14'\,56''.9$.
Extremely faint round coma 30″ in diameter. Total magnitude 15.5.

Periodic Comet 1925 II = 1937 *e* (Schwassmann-Wachmann). This faint object was found by the writer on plates taken May 6 with the 24-inch reflector of the Yerkes Observatory.

1937 May 6.23030 $\alpha = 13^h\,43^m\,34^s.21$ $\delta = -22°\,10'\,25''.4$ Mag. 15.5.

This made it possible to locate the comet on a number of earlier plates beginning January 16, when the magnitude was estimated as 17. At previous oppositions this distant comet, whose slightly eccentric orbit is situated between the orbits of Jupiter and Saturn, has shown striking changes in brightness although its distance from the sun varies quite slowly. A few days after the recovery this year, changes in the appearance of the comet became evident. On May 15 it had brightened up to 13.5 magnitude and at the same time the coma had shrunk to a small disc of hardly 10″ in diameter. Two days later the comet was fainter and much more diffuse again. How large are the variations in magnitude can be seen from the following table:

| 1937 | M | 1937 | M |
|---|---|---|---|
| Jan. 16 | 17 | May 8 | 15 |
| Feb. 17 | 16 | May 10 | 16.5 |
| Mar. 17 | 16 | May 15 | 13.5 |
| May 6 | 15.5 | May 17 | 14.5 |

Of the comets previously observed this year only 1937 *b* (Whipple) remains in reach of modest instruments. The predicted brightness indicated on p. 265 is close to the truth so that we can expect nearly constant brightness during June and July. The comet is favorably situated in the constellation of Boötis; it presents a sharp, almost stellar nucleus; the coma extends into a broad tail in a south-preceding direction, and in addition on May 6 there was a slender threadlike tail extending to 10′ from the nucleus.

Comet 1937 *c* (Wilk-Peltier) is now no longer observable. I recorded it last on May 8 as an extremely diffuse coma of magnitude 15 which was rapidly losing in brightness.

Williams Bay, Wisconsin, May 20, 1937.

# METEORS AND METEORITES

## Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

The winter, since the Quadrantids appeared, and the spring to date have been lacking in anything of interest as to meteors. Only one bright fireball has been reported from this region, which appeared on 1937 April 15 at 11:50 P.M. Its brightness seems to have been about that of the quarter moon, but only six people have reported it. We urgently need nore observations. Only a few isolated reports of no special interest have come in from people doing routine observing. It is hoped that the Eta Aquarid meteors, due in May, will be fully observed. Their connection with Halley's Comet makes them of great interest. Bad weather in this region, as well as moonlight, ruined any chances to see the Lyrids. Though this appears many weeks before the Delta Aquarids of late July and the Perseids of July-August, the attention of our members should be called to these meteor showers. Of all times in the average year more meteors can be seen, with less discomfort, during the second half of the summer. It is hoped that numerous parties will be organized for coöperative work to obtain meteor heights. Also for persons with small telescopes of wide fields of view, telescopic observations of Perseids are urged. This work is as yet in its infancy and valuable results can be gotten for little labor. As the writer will probably be absent for part of the summer, all persons who want advice or supplies should write him during June and not put off to the last moment. Let us all combine to make the summer of 1937 one which will reflect great credit upon our Society.

The rest of these Notes will be taken up by the results for two fireballs and a review of the most recent reference book on meteoric astronomy.

### Fireball of 1934 April 5

A fireball described as half as large as the moon was observed from two ships at 4:32 on 1934 April 5. The reports were published in the *Hydrographic Bulletin* of the U. S. Navy.

S1. "Third Officer B. P. Bobbitt, of the American motor ship *Gulfpride*, Capt. O. Anderson, reports that at 0432 G.M.T., April 5, 1934, in lat. 31° 18′ N., long. 76° 50′ W., an exceptionally bright meteor was observed. The body appeared bearing about 210° from the ship, near the star ι Antliae, at an altitude of about 20°, and dropped vertically, exploding and disappearing at an altitude of about 8°. In color the body appeared bluish white, changing to reddish white just before the explosion. The sky was clear . . ."

S2. "Third Officer L. H. Winder, of the American steamer *E. M. Clark*, Capt. J. Tweed, reports that on April 5, 1934, at 0432 G.M.T., in lat. 30° 06′ N., long. 76° 50′ W., a white meteor, nearly half as large as the moon, was observed. The body appeared close to Regulus and disappeared close to Procyon, lasting about a second, during which the whole horizon was lighted. A red and greenish trail was left by the meteor . . ."

Using the position of Regulus and Procyon as the beginning and ending points of the object as seen from S2, and the average of the estimated azimuth and the azimuth of ι Antliae for S1, the following data were derived. The coördinates of beginning and end points were not calculated, but were taken from a large celestial

globe, this procedure being justified as the data given were only approximate.

| | | |
|---|---|---|
| Sidereal time at end point | | 184° |
| Beginning height | | 96.7 ± 22.5 km |
| End height | | 23.6 ± 0.4 km |
| Projected length of path | | 28.4 km |
| Actual length of path | | 99.4 km |
| Radiant (uncorrected) | a = 24° | h = 69° |
| | α = 173° | δ = +10° |

No fireball from this position is found in the von Niessl-Hoffmeister Catalogue.

### Fireball Off Virginia Capes 1934 May 20

A brilliant fireball was observed on 1934 May 20 at 8:44 P.M., E.S.T., from the American ship *Gulfhawk*, from the German ship *Skagerrak*, and by E. E. Bagwell at Cheriton, Virginia. These stations will be designated in order S1, S2, and S3. The usual solution was attempted by plotting the stations on a map and laying off the azimuth lines; the altitudes can then be used in computing the true height.

This procedure soon showed that while the observations from S2 and S3 agreed well with one another, part of those from S1 could not be fitted in at all; also at least one ambiguity appeared among the S1 data themselves.

The data were as follows:

| | | | —Beginning— | | —Ending— | | Dura- | |
|---|---|---|---|---|---|---|---|---|
| St. | Long. W | Lat. | Alt. | Azi. | Alt. | Azi. | tion | Color |
| | ° ′ | ° ′ | ° | ° | ° | ° | s | |
| S1 | 74 50 | 36 00 | 55 | 315 | 45 | 135 | 3 | Bl-Wh |
| S2 | 73 50 | 35 07 | 50 | 192 | 20 | 180 | Slow | Gr-Wh |
| S3 | 75 58 | 37 18 | 35 | 292 | 25 | 270 | 5 | Fire |

The following results were derived:

| | | |
|---|---|---|
| Sidereal time at end point | | 190° 19′ |
| Began over | λ = 73° 28′ W | φ = +36° 26′ |
| Ended over | λ = 73° 50′ W | φ = +37° 18′ |
| Beginning height | | 179 km ± 3* |
| End height | | 92 km ± 1 |
| Length of path | | 133 km |
| Projected length of path | | 100 km |
| Observed slope of path | | 41° |
| Azimuth of motion (toward) | | 161° |
| Radiant (uncorrected) | α = 204° | δ = −09° |
| Observed velocity | | 32 km/sec |

*Deviation from the mean.

Neglecting the beginning azimuth from S1 entirely, the altitude for beginning point gave a fair check on the computed height from the other two stations, 191 km, but both altitude and azimuth for the end point are hopelessly discordant with the other data. S1's observation is obviously not clearly reported, as the beginning point was given as southeast, and the end point as northwest, but the meteor, it was stated, did not pass directly overhead. The solutions given above are based therefore on data from S2 and S3. Their singular accordance is fortuitous, and the results cannot be considered very accurate. It seems useless therefore to compute an orbit.

No recent fireball found in the von Niessl-Hoffmeister catalogue has a radiant near that of this object, which seems therefore not to belong to any well-known stream.

The appearance of a book* on meteoric astronomy by C. Hoffmeister, the outstanding authority on the subject in Germany and a man of great practical experience in the observation of meteors, will be welcomed by everyone. This is especially true as the last decade has seen important work by many men which has greatly increased the interest in meteoric astronomy and the relative importance of it in the mind of the average professional astronomer. Also there is no one better equipped than Hoffmeister to speak with authority on the subject in which he has labored with conspicuous success for over a quarter of a century. The one unfortunate thing about the book, from the standpoint of most of the people working on meteors in America, is that it is in German. It is hoped, however, that all seriously interested will obtain a copy and find some way of having it read to them, if they are themselves unable to read it. It will well repay their trouble, and the book is a short one. In any case the tabular matter and tables will be intelligible, along with the splendid bibliography of the more important meteor articles of the past century, covering 16 pages with 322 entries. This list alone would make it worth while for every member of the A.M.S. to secure a copy of this book. It is the most complete list the writer has seen.

The book proper is divided into two main sections: the astronomical part and the geophysical part. The first has four sub-heads: the observations, the problem of velocity, cometary meteors, and interstellar meteors. In any review, only certain points can be mentioned. The problem of velocity is one of fundamental importance and general interest. Hoffmeister was the first man to bring proof that most meteors have hyperbolic velocities and hence come from without the Solar System. His views were anticipated by some earlier work, especially that on fireballs by von Niessl. This latter has been often attacked, more recently by the late W. J. Fisher of Harvard and by C. C. Wylie. Hoffmeister is, however, a strong believer in the validity of von Niessl's conclusions on fireballs, which have been reinforced by some work of his own on more recent cases. As to the small meteors, he has developed the theory of Daily Variation in a masterly way, using not only his own observations but older series. From four such series he has derived an average heliocentric velocity for small meteors of 2.4 times that of the earth. Considerable space is devoted to this subject, which is followed up by the sections on the Interstellar System of small bodies. A.M.S. members will understand that their own work in the current Hoffmeister-Olivier program is intended to give new data for more complete solutions of these very problems. Hoffmeister also studies the influence of the observer's latitude and of the seasons on the hourly rates of meteors. From a discussion of the work of the Harvard expedition to Arizona, the results of which are being mostly worked up under the direction of Öpik, and part of which is already available, Hoffmeister is able to indicate complete confirmation on this question. For they too by a wholly different method (i.e., the rocking mirror) led to hyperbolic velocities. Hoffmeister shows that the two interstellar currents of meteors, whose asymptotic directions at $\lambda = 37°$, $\beta = 0°$ and $\lambda = 221°$, $\beta = +2°$ are about 176° apart (these are the Taurus and the Scorpius streams), have heliocentric velocities of 2.45 and 2.24 times that of the earth, respectively. When we eliminate the velocity of the sun through space and refer this to the stars, these figures become 2.3 and 1.6, respectively, but in *both cases* still hyperbolic. Everyone will at once notice similarity to the phenomenon known as star-streaming.

*"Die Meteore," by C. Hoffmeister, Akademische Verlagsgesellschaft, M.B.H. Leipzig, 1937. Pp viii + 154, with 25 diagrams and 4 plates. Price M. 9.60.

Hoffmeister is no believer in determining radiants from few or badly observed meteor paths. He does not hesitate to agree fully with the writer of this review that stationary radiation, which about 25 years ago caused such a controversy between the late W. F. Denning and Olivier, does not exist, and that the question is a dead one. Incidentally in a similar review of the book under discussion, in the *Journal of the B.A.A.*, **47**, 192-93, 1937, and signed by M.D., this question is mentioned but it is carefully omitted to say that Hoffmeister fully agrees with the stand taken by Olivier. Such an omission seems very strange, if the matter were to be mentioned at all.

The first portion of the geophysical section deals with the heights of meteors. Recent work by American, German, and Russian observers is reviewed. Among others the work of Wegener, Maltzev, and Astapowitsch, much of which is difficult for most observers to see in the original, receives adequate treatment. For the telescopic meteors it seems that, from direct observations, the heights are no greater than for ordinary shooting stars. Hoffmeister believes in the reality of certain heights for fireballs of over 400 km. He, as nearly all others, comes to the conclusion that the masses of meteors are usually only a fraction of a gram. Many pages are filled with the fundamental and as yet incompletely answered question—*why* does a meteor shine, his own theory being given among others. This brings in a discussion of the atmospheric resistance, with all its implication. The difficulties are clearly pointed out, and when one sees how many assumptions have to be made, and how few data are even approximately known, one no longer is surprised at the divergences of opinion of the best investigators. The light curves of meteors are studied, largely based upon photographic results. The excellent work of Millman on the spectra of meteors, the first, indeed, ever carried out on a large scale, is given the prominent place it deserves. As to long-enduring meteor trains, Hoffmeister tends to believe that the conclusions by Trowbridge have the greatest probability. But he acknowledges that many problems relating to trains are as yet unsolved, among others: why do certain meteors leave trains of long duration while others, superficially exactly similar in brightness, color, angular velocity, and even class, leave none or very short-lived ones? There is an illustration of the 2-hour train observed in South Africa, 1912 June 2. The work of Kahlke on the directions of the drifts of trains is reviewed at some length.

Then follow several brief sections on the application of meteoric phenomena to the physics of our atmosphere. These include attempts to estimate the temperature of the upper strata, for which very discordant results are obtained by different investigators; also the influence of meteors upon electrical waves and the ionization of the atmosphere. Certain curious lighting effects denoted as "Leuchstreifen"—largely observed by Hoffmeister himself—and the noctilucent clouds are both fully discussed. The last couple of pages deal with highly controversial questions, such as possible connections of meteors with various other atmospheric phenomena.

As this is the first general or comprehensive treatise on the subject that has appeared since the reviewer's own book "Meteors" in 1925, it is well to emphasize that, so far as possible, Hoffmeister has not taken up the phases of the subject which were most fully treated there. He has largely devoted his book to the developments of the past twelve years. This accounts for its brevity, and adds to its value. As German books are so often notoriously long, he has set an example, which it would be well for us all to follow, by putting down only what was important and leaving out non-essentials. The book deserves a place in the library

of every amateur interested in the subject, as well as of all professional astronomers.

Flower Observatory of the University of Pennsylvania,
Upper Darby, Pennsylvania, 1937 April 26.

# Contributions of the Society for Research on Meteorites

*Edited by* FREDERICK C. LEONARD, President, *and* H. H. NININGER, Secretary

## "Instructions for the Observation of [High Temperature Effects Due to] Lightning," By L. A. Kulik*

*Translated by* LINCOLN LA PAZ *and* A. GERHARD WIENS,
of the Ohio State University and the University of Idaho

### PREFACE†

The highly interesting continuous and uniform scorching (in typical cases similar to the scorching caused by lightning) which I observed in the center of the radially blown-down woods at the place of the fall of the Podkamennaya Tunguska [Siberian] meteorite of June 30, 1908, induced me to make an attempt to collect observations of the scorching of diverse objects by lightning. The impulse to this undertaking was given by amateur observations sent to the Meteorite Department of the Mineralogical Institute of the Academy of Sciences of the U.S.S.R. Some of these observations describe lightning scorchings proper; others refer to problems concerning globe-lightning [ball-lightning], which as yet has not been explained by the physicists and is quite frequently mistaken for a bolide (or "fireball"—the effect of an [incandescent] flying meteorite) by the uninformed; still others report about "lightning arrows," *i.e. fulgurites*. The great interest connected with all these phenomena and the insufficiency of the material so far collected by science make our instructions so much the more essential.

The several years that have passed since I compiled these instructions (1928) have enriched the science of meteoritics with new facts that confirm the necessity of their publication. Thus, at the discovery in 1931 of the meteorite craters of Henbury, Australia, Dr. A. R. Alderman ascertained the striking similarity between fulgurites and the "quartz glass" of these craters which was formed by the melting of alluvial mineral deposits rich in silica during their explosive penetration by the gigantic fragments of this meteorite. On the other hand, Dr. L. J. Spencer, studying, in 1933, the "quartz glass" of these same craters and of the newly discovered craters at Wabar in Arabia, and also the so-called "glass meteorites" (*tektites*) arrived at the conviction of the identity of both.[1]

### I. INTRODUCTION

Lightning is a spark-like atmospheric electrical discharge of very high tension (tens of mllions of volts) and high temperature. Hence, when it strikes terrestrial objects, in addition to acting upon them mechanically, it often causes them to ignite, if they ignite easily, or to be scorched, or, lastly, to be melted. The effect of the action of lightning on living objects deserves careful study in itself. Lightning may leave traces on living flora (bushes, trees) that give valuable indications as to the character of this phenomenon. Finally, in penetrating the soil and melting the various minerals that compose it and the mineral layer under-

neath it, lightning furnishes data for determining its temperature at the moment of its action upon a given mineral.[3] Lightning occurs in various forms. Of special interest is globe-lightning [ball-lightning]. Photographs of lightning as well as of the effects of its action upon animate and inanimate objects are very valuable.[3]

II. Meteorological Observations

1. Place of observation (republic, province, district, city, or village).
2. Year, month, and date of occurrence.
3. Time of beginning and of end of thunderstorm (hour and minute).
4. Direction of first and of last thunder.
5. Direction of motion of storm-clouds.
6.[4] Time of beginning and of end of rain and hail.
7.[5] Amount of rain and hail, and form, dimensions, or weight of individual hailstones.
8. Name in full and exact address of observer.

III. Observations on Trees (and Bushes)

1. Time at which lightning struck tree (hour and minute).
2. When did it rain: at the moment when the lightning struck the tree, before it, or after it?
3. Species of tree struck by lightning; its height and thickness, and its position in the locality (in the woods, dense or sparse, on the outskirts of the woods, or in the open).
4. Did the lightning leave on the trunk and branches of the tree distinct traces of damage on bark and wood in the form of furrows, splinters, torn and chipped fragments of the tree, and what was the character of the damage?
5. How far from the tree were the torn or chipped fragments thrown, and what were the character and the degree of the scorching of their bark and wood and of the bark and wood of the tree at the place where these fragments were torn or chipped away?
6. When the lightning struck, were the leaves charred or scorched? If so, indicate to what extent and just at what point in the leafy part of the tree.
7. If the leaves were not charred (scorched) but merely turned yellow, just when did they turn yellow: when the lightning struck or some time afterwards (just how long afterwards)?
8. Were there places on the tree where not only the leaves but also the tips of live twigs were scorched; just where?
9. What was the appearance of the scorched tips of the live twigs; did they end in a little charcoal beyond which, nearer to the tree, unscorched bark followed, or did the scorching, with traces of charcoal, continue farther along the twig; how did the scorching end in such a case: abruptly or gradually until it reached the vanishing point?
10. In case the scorching is limited to the very tip of the twig, it is desirable to determine to what part the charcoal is confined: merely to the wood, or to the wood and bark; one should record and also sketch the form of the tip of the charred twig.
11. Were any larger branches broken off? Indicate the thickness of the branches (in centimeters) at the point of fracture, likewise the character of this fracture, and note, especially, whether the fracture was charred or scorched (soot-coated) and to what part the traces of charring (scorching) were confined: merely to the wood or to the wood and bark and just in what measure to either.

12. What effect had the lightning on the dead twigs?
13. Was the bark of the tree scorched (charred); what was the character of the scorching of the bark on the thick branches and on the thin twigs, and on the trunk at the top and the bottom of the tree?
14. Was any separation (falling-off) of the bark from the branches observed after the tree had been struck? Indicate when and exactly from what branches (thick, thin, or end-twigs) and also whether the bark separated from the trunk and just at what place.
15. Take measures to save the tree from felling until the arrival of a specialist.
16. If you are dealing with an old case—the time of whose occurrence may be ascertained—describe in detail the condition of the tree as you found it.
17. Of material interest are prolonged observations, from year to year, of all the changes occurring in trees struck by lightning, even though they may be dead.
18. Full name and exact address of observer.

[IV.] Observations on the Soil

1. Did the lightning form, at the foot of the tree or in its vicinity, an aperture (a crevice, a hole) in the soil with smooth walls?[6]
2. Describe the character of the soil and the underlying mineral strata at the foot of the tree struck by lightning and also at the place of the aperture (crevice, hole) made by the lightning.
3. Record the degree of humidity of the soil and, if possible, the depth of the subsoil water.
4. If the fulgurite[7] was not extracted from the soil, take measures to guard it until the arrival of a specialist. If that is impossible, extract it yourself by way of careful excavation, remembering that a fulgurite may ramify greatly. One should extract the whole fulgurite, no matter whether its portions are substantial or not; the unsubstantial, loose parts should never be thrown away; one should pack them separately, record their exact position, and join them to the fulgurite afterwards, at the time of its transference to a scientific institution.
5. When extracting a fulgurite it is necessary—and this is the main point—to record exactly the depth and the position of the fulgurite and its parts in the soil with relation to the soil strata and the subsoil strata. One should make a drawing representing in cross-section the soil strata at the point of extraction of the fulgurite and on this drawing should mark the position of the fulgurite and give the scale. A photograph will, of course, be more valuable, but one should add a detailed description even to a photograph; without a description, the scientific value of the fulgurite is greatly decreased.
6. When extracting a fulgurite for scientific study, it is necessary to add a *soil monolith*[8] from the same section (pit), to the full depth of the fulgurite. Since the length of a monolith is usually limited to one meter, one may, in case the fulgurite extends to a greater depth, take two shorter monoliths, embracing the whole fulgurite; it is necessary to take two monoliths when the ramifications of the fulgurite spread into different strata or into nest-like inclusions of different minerals, even though they may be in the same soil horizon but cannot be embraced by the same monolith.

7. If it appears impossible to take a monolith, one should give as complete and detailed a description as possible, according to paragraph 5, with drawings and photographs, and also, in place of the monolith (or monoliths), he should take samples from every soil stratum or nest-like inclusion penetrated by the fulgurite; if, however, the soil strata are thick and the fulgurite extends deep into the soil, one should take samples every decimeter. The weight of each sample might be, *e.g.*, half a kilogram. The samples should be numbered and the places whence they were taken indicated with corresponding numbers on the drawing of the cross-section of the soil (see paragraph 5).
8. Year, month, and date of extraction of the fulgurite, monolith, or samples, as well as of the photograph and drawing, should be carefully recorded.
9. Full name and exact address of observer.

FOOTNOTES AND REFERENCES

*Published originally in the *Works of the Lomonossoff Institute of the Russian Academy of Sciences,* Part 2 (1933), pp. 83-87. Translated from the Russian of L. A. Kulik by A. Gerhard Wiens, Department of Modern Languages, The University of Idaho, at the suggestion and with the coöperation of Lincoln La Paz, Department of Mathematics, The Ohio State University. Words and footnotes inclosed in square brackets have been inserted by the translators.

†The editors [of the aforementioned *Works,* see preceding footnote] share the author's viewpoint regarding the necessity of collecting observations of the rare phenomenon of globe-lightning [ball-lightning], the more so since observers often confuse this phenomenon with the circumstances of the fall of meteorites, which are objects of mineralogical research. On the other hand, the editors [wish to] emphasize the fact that the problem of lightning considered broadly rests also on the problem of fulgurites, about which mineralogy has by no means said the last word. Finally, the editors consider it entirely appropriate that the author links the observations of the effects of lightning on terrestrial objects with the problem of meteorite falls in general and, in particular, with that of the Podkamennaya Tunguska meteorite, interest in which has grown especially in recent times in connection with the discovery of the Australian and other meteorite craters.—THE EDITORS [of the *Works of the Lomonossoff Institute*].

[1] [In this connection it should be noted that the striking similarity between the "glass meteorites" and fulgurites was pointed out long ago, *e.g.*, by J. W. Gregory, who suggested that *australites* are "aërial fulgurites" produced by lightning fusing the dust in the air during heavy dust storms. It is possible that certain of the curious glassy "meteorites" discovered in Kansas and elsewhere in the "dust bowl" may have originated in this fashion. It is more probable that they are slags from burnt straw stacks. Careful study of possible dust fusion by lightning, in the course of the present cycle of dense dust storms, is highly desirable, in spite of the fact that the curious great-circle distribution of the glass meteorites pointed out by K. de Boer ("Über die Fundortverteilung der Glasmeteoriten," *Astr. Nach.*, **234** (1929), 135) and the remarkable uniformity of their radium content as determined by V. S. Dubey (*Nature,* **132** (1933), 678) would seem to support the view that all tektites have a common cosmic origin.]

[2] [Measurements of residual magnetism in ores and rocks in the neighborhood of a spot struck by lightning can be used to infer a lower bound for the current strength in the discharge, as was long ago pointed out by F. C. Pockels (*Annalen d. Phys.*, **63** (1897), 195; **65** (1898), 458; *Meteorol. Zeits.*, **15** (1898), 41; *Phys. Zeits.*, **2** (1901), 306). More recently, C. T. R. Wilson (*Proc. Roy. Soc.*, Ser. A., **92** (1916), 555) and others have investigated the same problem by different methods. From a knowledge of the current strength and the duration of a stroke, it is possible to estimate the temperature resulting from the discharge. Since only lightning and lightning-like artificial electrical discharges produce temperatures of the order of those probably occurring when a crater-forming meteorite strikes the earth, the importance of studies in this field is obvious.]

[3] All information and materials should be sent to Leningrad: to the Mineralogical Museum of the Lomonossoff Institute of the Academy of Sciences of the

U.S.S.R., Leningrad, V. O., University Quay, 5. Letters to this address go without postage according to Articles 64 and 65 of the *Statutes of the Academy of Sciences of the U.S.S.R.* (*Collection of the Laws and Regulations of the Worker-Peasant Government of the U.S.S.R.*, July 1, 1927, No. 35, Section 1, Article 367, and the *Decrees of the Council of People's Commissars of the U.S.S.R.* of December 14, 1926, on mail-telegraph exemptions, *Izvestiya C.E.C.* No. 297, December 23, 1926.)

[4] If you are able to obtain a copy of the observations for this day at the nearest meteorological station, add it to your communication.

[5] Collect rain and hail in a clean vessel, transfer them at once, if possible, to a clean bottle, taking care that all sediment ("dirt") also is transferred, stop up the bottle tightly with a clean cork, pack it in a box, and send it to the Mineralogical Museum of the Academy of Sciences of the U.S.S.R. All expenses will be refunded upon receipt of package and communication of amount of expenses.

[6] Thus is formed a hollow pipe which becomes thinner toward the bottom, often ramifies greatly, and is popularly called a "lightning arrow," in scientific literature, a "fulgurite" (*fulgur-lightning*).

[7] "When lightning strikes into sand, it melts the latter by its extraordinary heat and forms molten channels or pipes glazed on the inside and covered on the outside with coarse and fine sand adhering to the molten [fused] wall. These subterranean lightning burrows which sometimes have the shape of ramified horns are called *fulgurites*, commonly, *lightning arrows*," *An Illustrated Popular Physical Geography*, by N. I. Zuyeff, St. Petersburg, 1870, p. 91 (see fig. 1 [omitted here]).

[8] A *soil monolith* is a solid sample taken from a cross-section of the soil in the form of a vertical pillar [column]. Its usual dimensions are: length, 1 meter; width, 20 centimeters; thickness, approximately 3 centimeters. The monolith is packed in a tight box that corresponds exactly to regulation dimensions in such manner that no displacement of its parts may occur in transportation.

### The Fifth Annual Meeting

Attention is called to the notice which appeared in the *C.S.R.M.* in the current April issue of *P. A.*, p. 218, concerning the Fifth Annual Meeting of the Society, scheduled to be held on Tuesday, June 22, and Wednesday, June 23, 1937, at the Colorado Museum of Natural History, Denver, Colorado, in connection with the one-hundredth convention of the American Association for the Advancement of Science and its Western Divisions.

The session on Tuesday afternoon, June 22, will be a joint meeting with Section E (Geology and Geography) of the American Association for consideration of the subject of "Meteorite Craters." A number of leading geologists who have had experience with meteoritic craters have been invited to participate in the discussion. It is expected that this joint symposium with Section E will be one of the most interesting features of the Fifth Annual Meeting, at which papers from members not only in the United States but also in several other countries, including England, the U.S.S.R., and Czechoslovakia, are scheduled to be presented.

*Secretary's Office:* Nininger Laboratory, 1955 Fairfax Street, Denver, Colorado
*Editorial Office:* Department of Astronomy, University of California at Los Angeles

### Fireball Observed

The following is a report on a fireball seen on May 9, 1937, at about 9:36 P.M., C.S.T., as witnessed by two observers. Path was about 20° long, began due east 15° off horizon near star $\beta$ Ophiuchi, and sloped slightly down while traveling to the north. Rather slow in motion, but left no remaining tail. It was red in the beginning but changed to brilliant green and broke into three pieces at end of

path. Was the brightness of Venus or more. It may have begun more to the south than indicated and ended somewhat behind trees. No explosion was heard.

3207 Cornell Street, Des Moines, Iowa. HUGH M. JOHNSON.

# VARIABLE STARS

## Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

*A.A.V.S.O. Photographic Regions:* Regions 3 and 4 of the recently inaugurated A.A.V.S.O. program have been successfully photographed by Lynn H. Matthias, Chairman of the Photographic Committee. These were secured with a 3-inch photographic lens of 24 inches focal length, giving a field covering 7 degrees in declination and 35 minutes in right ascension, and a smaller lens of 7 inches focal length, covering a field of 27 degrees in declination and $2^h\ 10^m$ in right ascension. The larger scale plate appears to be more suitable for the study of individual stars, while the small scale plate serves best for the detection of new objects, such as variables, comets, and novae. All had exposures of 20 minutes each and the 20-inch focal length lens shows stars well below the 11th magnitude.

Field No. 3 has its center at $5^h\ 15^m$ —3° (1950) and the following variables have been identified in the area defined by the limits $4^h\ 55^m$ to $5^h\ 35^m$ in right ascension, and from +2° to —8° declination.

REGION No. 3

SY Eri, 0504*05*; A star of N0 type spectrum, visual range between 9.0 and 9.6, according to Webb and Espin, listed in Birmingham Catalogue of red stars and evidently of irregular type of variation.

WW Eri, 0500*07*; An eclipsing star, period $0^d.92$, photographic range 8.0 to 10.5, spectrum A5, light curve greatly needed.

S Ori, 0524*04*; Long-period variable observed by A.A.V.S.O. for many years, M7e spectrum; mean visual range 8.4 to 13.0, period 415.8 days; light curve presents maxima and minima of similar shape, descent to minimum slightly more rapid than rise to maximum.

T Ori, 0530*05*a; Irregular variable on the A.A.V.S.O. list, situated in the midst of the Orion Nebula, visual range 9.5 to 12.0, with sudden large fluctuations in light; may be considered a typical star for class of variation noted for such stars as RR Tau, R CrA, R Mon, V Sge, etc., should not be considered an R CrB type variable.

W Ori, 050001; Star having N5 type spectrum; visual range 5.8 to 7.2, photographic range 8.5 to 11.5, short term period of 200 days within a long term period of 2000 days; similar to V Hya in type of variation.

RY Ori, 0527*02*; An irregular variable; photographic range 9.0 to 11.4, about which little, if any, further information is known.

UX Ori, 0459*03*; Photographic range 9.2 to 10.5, very little information at hand; variation apparently irregular.

AN Ori, 0530*05*t; Irregular variable in Orion Nebula, photographic range 10.3 to 11.0, visual range 11.4 to 12.3; difficult to observe visually or photographically.

BM Ori, 0530*o5*; An eclipsing variable, visual range 8.1 to 8.7, period 6.47 days, spectrum Oe5. One of the stars of the Trapezium in the Orion Nebula.

CI Ori, 0524*o1*; Classed as an irregular variable; photographic range 5.1 to 6.2; K5 spectrum. An important star to observe.

DH Ori, 0520*oo*; Probably a long-period variable with period of 160 days, visual range 9.4 to [11.7.

EW Ori, 051401; Suspected to be an eclipsing star, with photographic range between 10 and 11. Very little is known about this star.

EX Ori, 0519*o6*; Photographic range 9.5 to 10.5, very little information at hand.

EY Ori, 0526*o5*; An eclipsing star, period 16.79 days, spectrum F8, with visual range 9.5 to 10.3. Light curve greatly needed.

δ Ori, 0526*oo*; An eclipsing star with very small range, visually 2.5 to 2.6; period 5.73 days, spectrum Blnk. Should be observed with photoelectric photometer.

The original center of Region No. 4 has been changed from $6^h\,15^m$ $+19°$ (1950) to $6^h\,15^m$ $+24°$ (1950) in order to facilitate locating the variables to be studied. The following variables are to be found in the limits defined between $5^h\,50^m$ to $6^h\,30^m$ in right ascension and $+19°$ to $+29°$ in declination.

REGION NO. 4

RW Gem, 055523; An eclipsing star with period of 2.87 days, visual range 9.6 to 11.6, spectrum B8.

SS Gem, 060222; Semi-regular variable, with double period of 89.31 days, visual range 8.6 to 9.3, spectrum G5v, light changes resemble those of R Scuti in their general behavior, and it is allied to the RV Tauri type stars.

SV Gem, 055424; An eclipsing star with period of 4.01 days, visual range 10.0 to 11.3, spectrum A.

TT Gem, 061919; The existence of this star as a variable is much doubted by astronomers who have carefully indentified it.

TU Gem, 060426; A star with an N3 type spectrum, visual range 7.4 to 8.3, probably irregular, although Becker has suspected a period of 432 days which is not inconsistent with the behavior of a star having this class of spectrum.

TV Gem, 060521; Semi-regular variable with period of 475 days assigned by Seliwanow, visual range 7.0 to 7.8, spectrum Ma. Wendell found a photometric range of $0^M.8$.

WW Gem, 060623; An eclipsing star, period 1.24 days, visual range 9.9 to 10.5, spectrum B5.

WY Gem, 060523; An irregular variable, visual range 7.4 to 7.9, spectrum M3ep, indicating peculiarities to be found in spectrum; not unlike the spectrum of VV Cephei, which has recently been found to be an eclipsing star.

ZZ Gem, 061625; Another Nb type spectrum, visual range 8.9 to 9.9, period unknown, very faint star photographically, having large color index.

AA Gem. 060026; A Cepheid variable, period 11.30 days, visual range 9.3 to 9.9, spectrum K0.

AB Gem. 062019; An N3 type variable having spectral peculiarities, visual range 8.3 to 9.8, photographic range 13.8 to 14.6; see ZZ Geminorum for similarities.

AY Gem, 062519; An eclipsing star with period 3.05 days, photographic range 10 to 11, light curve and spectrum much needed.

Eta Gem, 060822; Well-known naked-eye variable, visual range 3.2 to 4.2, period 236 days, spectrum M2; with minimum more sharply

defined than maximum, light curve shows peculiarities similar to those of RV Tauri, and the star is known to exhibit variations in radial velocity.

*Observers and Observations:* The following observers have contributed to the A.A.V.S.O. for the first time: Frank Brown, Jr., Columbia, South Carolina; Augusto S. Maupmoé, Mixcoac, D. F., Mexico; Robert Peters, Victoria, B. C., Canada.

The names of those who have contributed observations during the month of April are listed below together with the number of variables and observations made by each. In spite of the prevailing cloudy weather reported from many parts of the world, there were sixty-four contributors, making a total of 3329 observations.

| Observer | Vars. | Observations | Observer | Vars. | Observations |
|---|---|---|---|---|---|
| Ahnert | 28 | 47 | Kitchens | 6 | 6 |
| Ashbrook | 3 | 11 | de Kock | 30 | 114 |
| Baldwin | 61 | 72 | La Fon | 12 | 15 |
| Ballhaussen, Miss | 6 | 6 | Loreta | 111 | 222 |
| Blunck | 20 | 26 | Marsh | 9 | 10 |
| Bouton | 48 | 84 | Maupomé | 6 | 6 |
| Brocchi | 11 | 18 | Millard | 17 | 18 |
| Brown, F. B. | 2 | 4 | Murphy | 5 | 5 |
| Brown, S. C. | 11 | 11 | MacCalla | 5 | 5 |
| Buckstaff | 7 | 28 | McLeod | 16 | 29 |
| Callum | 22 | 41 | McNabb | 2 | 11 |
| Cameron | 9 | 12 | Peck | 5 | 21 |
| Carpenter | 207 | 209 | Peltier | 168 | 187 |
| Chartier | 18 | 30 | Peters | 1 | 4 |
| Christman | 10 | 10 | Purdy | 5 | 5 |
| Doolittle | 5 | 7 | Rosebrugh | 54 | 107 |
| Ellis | 20 | 31 | de Roy | 13 | 78 |
| Ensor | 56 | 169 | Russell, J. | 3 | 3 |
| Escalante | 46 | 48 | Ryder | 5 | 7 |
| Fleischer | 2 | 4 | Schattle | 1 | 21 |
| Franklin | 16 | 20 | Scherr | 4 | 11 |
| Gregory | 31 | 37 | Sill | 27 | 27 |
| Hamilton | 6 | 15 | Smith, F. P. | 19 | 40 |
| Hartmann | 112 | 261 | Smith, F. W. | 1 | 2 |
| Herbig | 67 | 150 | Smith, J. R. | 11 | 11 |
| Hiett | 23 | 52 | Smith, L. | 14 | 20 |
| Holt | 33 | 33 | Taylor | 10 | 10 |
| Houghton | 82 | 219 | Thorne | 2 | 2 |
| Houston | 106 | 233 | Treadwell | 10 | 12 |
| Humbert | 5 | 5 | Webb | 37 | 44 |
| Jones | 106 | 300 | Yamasaki | 6 | 7 |
| King | 11 | 16 | | | |
| Kirkpatrick | 18 | 60 | 64 | | 3329 |

*A.A.V.S.O. Syracuse Meeting:* The Twenty-Sixth Annual Spring Meeting of the A.A.V.S.O., held at the University of Syracuse, on May 21 and 22, was a great success, when one considers the representative attendance, climatic conditions, and general enthusiasm on the part of many members who have been hitherto unable to be present at meetings of the Association. Toronto and Acton, Ontario, Canada, were represented, and from Milwaukee came a group, augmented by members from Chicago and Pittsburgh. New York State, both local and distant, was there in force, beside as large number from New Jersey, Massachusetts, and New Hampshire.

Twenty new members were elected by the Council; there was also one transfer

from Annual to Life Membership. Mexico, Canada, and South Africa were included in the territories from which new members were elected. Eight names were dropped from the membership list because of the lack of interest on the part of those individuals in the activities of the Association.

The Association was welcomed on behalf of the University by Acting Chancellor Graham, who recounted the past history of astronomy and of the Observatory at Syracuse. His deepest concern appeared to be for the future of the Observatory and he asked that suggestions be made along the line of progress in astronomy at this institution. Many suggestions were made, some serious, some otherwise.

The University of Syracuse proved to be an ideal spot for the meeting, with the facilities of the Library and Slocum Hall dining room so freely placed at the disposal of the Association.

It was decidedly a meeting where the non-professional played a major part in the program, especially in the presentation of papers and in the ensuing discussions. The only paper given by a professional member, Dr. Paul W. Merrill, of Mount Wilson Observatory, was one dealing with the changes in the spectrum, during the recent minimum, of R Hydrae.

The following papers were also presented:

"A Tribute to the Memory of J. Ernest G. Yalden,"
By J.A.Ingham, of Leonia, New Jersey.

"The Problem of the SS Cygni Stars,"
By Noah W. McLeod, of Christine, North Dakota.

"The Advantages of Observing Variables with Red Light,"
By C. R. Gregory, of Scipio Center, New York.

"Samuel Calthrop, Minister, Astronomer, and Chess Player,"
By L. L. Doolittle, South Norwalk, Connecticut.

"Astronomy at Trinity College,"
By Richard Hamilton, of Norwalk, Connecticut.

"Roof Observations,"
By J. S. Andrews, of Rutherford, New Jersey.

"A Star Comparator,"
By M. M. Dalton, of Alhambra, California.

The Nominating Committee presented the following slate of Council members to be voted upon at the October meeting:

Charles P. Olivier .....Upper Darby, Pennsylvania
Luverne E. Armfield .....Milwaukee, Wisconsin
Phoebe W. Haas .....Villa Nova, Pennsylvania
David W. Rosebrugh .....Poughkeepsie, New York

The afternoon session took the form of an automobile trip to the Chittenango Falls, some twenty-five miles distant. The automobiles of many members present from distant points, together with those kindly offered by the members of the Faculty of the University, served as a means of conveyance to and from the Falls. The excursion offered a splendid opportunity for old and new members to become better acquainted.

The usual banquet was held in the dining hall of Slocum House, where some fifty persons, including interested members of the Faculty of the University, enjoyed a delightful dinner as the guests of the University. Mr. L. E. Armfield, as toastmaster, introduced first a representative of the University and several members from the amateur and professional ranks of the Association; then, Dr. Shapley, who philosophized on how much better one could learn the secrets of the universe were he born with many more senses than he now possesses. The Recorder,

in responding to an invitation to address the assembly, commented in some detail on the light curves of peculiar variables, stressing the apparently close connection between stars of the types of variation indicated by T Orionis, R Coronae Australis, RR Tauri, V Sagittae, and the late-stage activities of many of the novae, in particular, those of Nova Persei 1901.

Secretary Elmer concluded the meeting with appropriate thank-yous, expressed in his inimitable fashion, for the many courtesies and favors tendered the Association on the occasion of this meeting.

The plan to hold an occasional meeting of the Association in some place rather far distant from New England proved to be a success; many members not heretofore seen at A.A.V.S.O. meetings were present.

It was voted to hold the next Fall meeting in October, at Cambridge, as usual, and the next Spring meeting at Brown University, Providence, Rhode Island, at a date in May, 1938, that will be acceptable to the University.

May 25, 1937.

## Notes from Amateurs

### Color Changes on the Moon

(Communicated by E. P. Martz, Jr., Planetary Director, A.A.A.A.)

The story of changes on the moon usually involves the careful delineation of delicate detail in a few restricted portions of the lunar surface. Such work requires a fairly good telescope and a trained eye and is greatly hampered by an unsteady atmosphere. The detailed study of a single object is the work of an observing-year. Another type of lunar change, for some strange reason generally ignored, can be studied by amateur observers with small telescopes in an unsteady atmosphere. We can see on the moon color changes in progress affecting areas as large as some of the New England states.

These changes are, moreover, of interest and importance. They are probably the least studied of a number of lunar riddles. The opportunity for mass-work is splendid here; for no eye is apt to be perfect in all its color-judgments, and as many objects as possible should be observed in order to determine what general trends exist and what natural laws control these color changes on the moon. In the author's opinion, we have here as promising a field for amateurs as variable stars.

A program of lunar color observation was undertaken at Mount Union College in 1936 with a 10-inch refractor; the work being supplemented by observations made at New Waterford, Ohio, with a 6-inch reflector. A total of 496 observations was made by 25 observers, the author contributing 383. Among other observers at Mount Union were Mr. Roth (28 observations), Mr. Peeling (5 observations), Mr. Weldy (6 observations), and the members of the astronomy class (31 observations). Contributing observers were Mr. James Buchanan of Youngstown, Ohio, Mr. Edwin P. Martz of Chicago, and Professor W. H. Pickering of Jamaica. The results of this work and the possibilities for future work will be considered in this article.

The colors seen come under three general classifications: (1) Colors seen in shadows, the usual deviation from jet black being a deep chocolate brown. (2) Colors seen on crater floors at sunrise or sunset, these hues being usually green but sometimes brown. (3) Colors seen on crater floors under a high sun; these colors being green, brown, or purple. It is possible that there are other tints.

We are now ready to consider techniques in observing.

In choosing an object for observation, it is well to choose one visible under all angles of illumination. This choice usually means an object with a dark floor. It is also well to avoid objects too near the limb because such objects will be difficult to observe either at sunrise or sunset. Work will have to be done on such objects on the crescent moon just after terrestrial sunset or just before terrestrial sunrise. Observers not caring for post-midnight work will do well to choose objects west of the moon's central meridian.

A comparison area that may be considered gray is essential to making observations objective. We have such areas in the large lunar *maria*. Try to choose a *mare* several days from the lunar terminator and compare the object to the *mare*, the latter being considered neutral gray.

Color filters are very helpful, not only in bringing out vague tints but also in making the colors more objective. The author found colored sunglasses very useful as color filters. Pale greenish, greenish blue, reddish brown, and purplish lenses were used in observing the plains; a dark brown lens was used on the shadows. Mr. Buchanan recommends two thicknesses of pink cellophane for bringing out vague greenish hues.

The following things should be recorded with each observation: (1) The date and time. (2) The state of the sky. It may be recorded as clear, slightly hazy, moderately hazy, or very hazy. This is important, for haze affects colors by reducing the moon's light. The illumination of the sky around the moon is a good indication of how much haze is present, but allowance must be made for phase. (3) Color filters used. (4) The telescope and magnification employed. The following might be a typical entry.

May 1-2, 1936. 10:38 C.S.T. *Grimaldi*. Slightly hazy. Greenish blue color filter. 134×. The floor is a distinct greenish gray. ——— observer.

If date and observer can be recorded elsewhere, it may be well to record results in a table of six columns, noting the effect of each color filter separately.

We shall now consider results of 1936 work. Only objects observed more than five times are included.

ATLAS. 20 observations. The darker parts of the floor are brown or purplish brown. The hue is present two terrestrial days after lunar sunrise on Atlas and is still present at sunset, being affected only by changes in the dark regions themselves.

BILLY. 12 observations. Like Atlas, this crater is brown in the darker parts of its floor. Any changes during the lunation are probably very slight.

CRISIUM, MARE. 14 observations. This *mare* has a distinct greenish cast at sunrise. The hue fades in one and a half terrestrial days, perhaps sooner. Roth and Weldy saw pinkish spots, which the author could not confirm, near the south end of the *mare* on June 22.

CRÜGER. 7 observations. Its floor is brownish at sunrise and again in the late afternoon, perhaps being gray under a high sun.

ENDYMION. 24 observations. Its floor is very dark at sunrise and may be brown. Two terrestrial days after sunrise, the brown is confined to a narrow strip under the northeast wall, the rest being gray. Changes begin three days before sunset. The brown develops again under the east wall. The rest has a growing greenish tinge until the whole floor is vividly green at sunset.

EUDOXUS. 7 observations. The sunrise shadow is browner and darker than that of its neighbor crater, Aristotle. The difference is very easily seen.

FURNERIUS. 14 observations. At sunrise the floor has a greenish cast over all but the southeast quadrant, which is brown. This observation should be made on a clear evening in spring as soon as the moon is bright enough to show colors well. The hue soon fades. The floor is gray at sunset, except for a band down the middle.

GRIMALDI. 73 observations. The large number of observations indicates color changes as follows: The floor is green at sunrise, looking very green with a very high moon on a very clear evening in February. The green slowly fades into a greenish gray. Twelve terrestrial hours after sunrise, brownish splotches appear on the walls; and twenty hours later Grimaldi has assumed its typical appearance. The south, east, and west walls are brownish gray; the floor is greenish gray. Some observers see only the green floor, and others see only the brown walls. Either type will need color filters to get a true picture of the crater. The brownness of the walls is mixed with purple, the southeast wall being especially so affected. These purple tones are best seen a short time after full moon. Mr. Martz observed that the green tone is stronger over the south half of the floor than over the rest. The green behaves peculiarly after lunar noon. For a time it seems to fade out entirely. It is at times much more distinct than earlier in the lunation. It is suspected that the tone varies irregularly, but it may only be that the color becomes stronger as lunar afternoon progresses. Two days before sunset, the floor is still greenish; and the walls are still brownish. Both hues quickly fade into gray. Sunset observations of Grimadli should be made on autumn mornings.

HERCULES. 20 observations. This crater is similar to its neighbor, Atlas. Its darker parts are purplish brown and are subject to no changes except these affecting the dark areas themselves.

PHOCYDIDES. 10 observations. Its sunrise shadow is the best established of the brown shadows. The large neighboring crater of Schickard contains an ideal comparison shadow. The chocolate tint in Phocydides has been seen in five different lunations. Several observers besides the author have worked on this shadow. Not all see the chocolate hue he does, but all agree that the shadow differs from that of Schickard in darkness and probably in color.

PLATO. 80 observations. Although this was the best observed object on the moon for color in 1936, its study is complicated by the vagueness of the green and brown tints present and by the fact that most eyes see only one of the colors. Mr. Buchanan's eleven observations were made on this crater and assisted considerably in determining the probable course of color changes. The green is vaguer than in Grimaldi, and the brown is a delicate brownish grey. The probable course of development is as follows: The floor at sunrise has a greenish cast, with a brownish area under the east wall. This east edge retains its distinctive color for three days but is often difficult to see because of its small size. The remainder of the floor becomes a green-brown, gradually fading into gray. The hue is interpreted as brownish green by some and as greenish brown by others. Three days after sunrise, Plato assumes a splotched appearance; several difficultly visible, darker areas of irregular outline appearing on its floor. These darker areas are brownish gray. The general tone of the floor is greenish and this tone very slowly darkens to an olive green. Changes begin again three days before sunset. The brownish gray splotches slowly fade; the green-brown tone of early morning reappears; the east edge becomes greener, not browner as in the forenoon, than the rest; and the entire floor is a distinct green-brown at sunset.

RICCIOLI. 52 observations. What was really observed was the west side of

the dark region within Riccioli. This dark region is well formed very shortly after sunrise and does not break up until sunset has nearly arrived. As long as the dark region is well formed, its west side is a very peculiar deep purple-gray-brown. It is very difficult to describe the color to one who has never seen it. It is more purple than anything else, but the purple is seldom striking except with a purple color filter. This area does not have its characteristic color before the dark region is well formed or after it disintegrates.

ROCCA. 21 observations. The floor is gray at sunrise. A purplish-brown hue develops on the edge thirty hours later, and twenty hours later the edge is noticeably purplish, more purple than Riccioli. The purple is very distinctive for a time. It begins to fade a little before lunar noon as the area itself fades, and is completely gone in about four days. The purple cast was gone much earlier in the September-October lunation. There may be purplish strips on the walls at sunset.

SNELLIUS. 23 observations. Its sunrise shadow was a comparison shadow for Stevinus observations. See STEVINUS.

STEVINUS. 70 observations. For early results on Stevinus, see *Amateur Astronomy*, March, 1936; also July, 1936. The sunrise shadow of this crater is the most observed but not the best established of the brown shadows. The shadow of Snellius was used as a comparison shadow. Twelve observations on March 26 establish that at sunrise this shadow is not nearly so dark as that of Snellius. To the author, this darkness of Snellius seems to include a deep chocolate brown hue. Most observers, however, consider the Stevinus shadow browner. It seems probable to the author that ten hours after sunrise, the time beyond which Professor Pickering has never seen Stevinus brown, is the time at which the Stevinus shadow becomes darker than that of Snellius. The Stevinus shadow is certainly darker thirty hours after sunrise. To the author it seems somewhat brown from this time until it disappears. Roth, however, saw Snellius as browner thirty hours after sunrise, Weldy saw brown in both shadows, and Martz considered the Stevinus shadow black at this time.

As the puzzling shadow becomes too small to be seen, color changes begin on the floor of Stevinus and over a large area south of the south wall. Very vague brownish tints are first noticed about fifty hours after sunrise. The brown hue is well developed two days later and has faded to gray about a day before lunar noon. Mr. Martz's observations confirm the foregoing statements. The appearance and disappearance of the hue is somewhat irregular. The color endured nearly until sunset in the July-August lunation and until a day after noon in the following one. The appearance may have been late at times; but this is uncertain, for the hue is very vague when it first appears.

The preceding discussion, backed by nearly five hundred observations, justifies three statements:

1. Colors other than black, white, and gray exist on the moon.
2. These colors are subject to changes.
3. These changes are not confined to a few isolated craters but represent a general phenomenon affecting the entire moon.

In regard to the first statement, we need only say: If six to a dozen observers, all previously uninstructed about what to expect, all see the same hue in a crater, even though they may describe its intensity very differently, we are certainly justified in considering the hue objective. The author does not at all doubt the greenishness of Plato under a high sun, even though he cannot see the tint himself. Some eyes probably cannot see any colors, and the beginner will do well

to observe the moon as far from full as possible. The astronomy class at Mount Union found the brightness of the full moon a distinct handicap.

That the changes are objective cannot be demonstrated quite so simply. It is usually necessary to rely upon the work of one observer and to accumulate as many observations as possible. When the same result is obtained lunation after lunation, however, or when two observers working independently see the same thing, there can be little reasonable doubt of the significance of the result. The author could readily name twenty changes with the times at which they occur.

The third statement is easily proved. Anyone (whose eye was not completely insensitive to all colors) who should attempt to ascertain the number of color changes without regard to what course of development these changes take would doubtless find that a large number of objects are subject to change. The author is of the opinion that there are at least a hundred areas on the moon subject to color changes at some time in the lunation. Here are four observations which have not been followed up at all: 1. Mare Humorum—greenish tints at sunrise. 2. Mare Imbrium—greenish tints at sunset. 3. Julius Caesar—floor greenish gray at sunset. 4. Nersenius—floor very brown at sunset. The number of brown shadows is large. The author's eye is too prone to see this hue, but the shadows in the following craters are probably different from their neighbors in darkness and perhaps also in color: Vieta (sunrise), Pythagoras (sunrise), Zuchius (sunset), Petavius (sunrise), Claproth (sunrise), Scheiner (sunrise), and Aristarchus (sunrise and unset).

It is too early to attempt to derive explanation, for we do not even know the general laws controlling lunar color phenomena. Realizing these difficulties, the author would like to make a few suggestions.

The most natural explanation of abnormal shadows is a twilight effect of some kind. The slight difference in shadows would indicate that the medium causing the effect is very tenuous indeed.

Colors on crater floors under a high sun can be most naturally ascribed to some low form of vegetation. The two most common hues, green and brown, favor this explanation; and the occasional irregularities in development certainly point to this as a reasonable explanation.

Colors on crater floors at sunrise or sunset might be ascribed to the colors of the rocks themselves. The difficulty with the explanation is that the areas are sometimes gray under a high sun. Perhaps we have some abnormal kind of vegetation, flourishing only at sunrise or sunset.

But even if we have failed to find the cause of lunar color changes with certainty, we have opened a promising field for observation. Any of the objects enumerated in this article would be worth continued study. It is the author's intention to continue lunar color work in 1937, and he would be glad to hear from any interested observers. By coördinated observation alone can we hope to solve the mysteries of the greens, browns, and purples on the rugged moon.

Mount Union College Observatory, Alliance, Ohio. WALTER H. HAAS.

### Amateur Astronomical Society of New Haven

At the meeting of the New Haven Amateur Astronomical Society held on April 24, Dr. Brouwer of Yale gave an interesting account of the transit of Mercury on May 11, explaining it by means of blackboard sketches and diagrams. He informed the group among many other interesting facts that the scheduled transits

of Mercury were six in forty-six years and of Venus only four in 243 years.

Mrs. Partridge gave an interesting account of the two expeditions being arranged to witness the solar eclipse of June 8 whose period of totality is from four to seven minutes duration which is the longest duration of totality of a sun's eclipse in 1200 years, but unfortunately the path will touch very little land. One expedition will view it from Enderbury Island in the Pacific, which is an uninhabited spot, one by one and a half miles. The Hayden Planetarium party of thirteen will view it from Lima, Peru.

Mrs. Rademacher reported on the activities of the observing group which on April 21 observed the meteor shower of Lyrids. The group consisting of ten members observed from twelve to two-fifteen A.M., working in conjunction with a group at Vassar College to observe for height. The bright moon (nine days old) interfered somewhat but thirteen meteors were observed and charted and reports sent to Vassar College. The group were quite pleased to receive word that eight of the thirteen we charted had been checked as simultaneously observed in Schenectady.

Dr. Stephen, Curator of Babylonian Collections at Yale, gave a very interesting talk on Astronomy in 2000 B.C. He informed the Society that the Babylonians were the pioneers in astronomy, or rather its predecessor astrology, and they studied it not only to keep correct time but also for religious purposes and to keep their king informed of future happenings that would affect both the king and his people. Tablets show that observations were made as early as 2500 and 3000 B.C. The moon was the standard which governed the length of the month. Each new moon was the beginning of a new month. If cloudy weather interfered with observations, the month would be of the standard thirty days but, if clear skies permitted, the appearance of the new moon was immediately announced and automatically the new month began.

In 2000 B.C. the Babylonians had observed and knew of five planets of our system. They recorded a twelve-hour day, instead of twenty-four, with a one hundred and twenty minute hour.

Dr. Schlesinger, head of the Yale Astronomical Division, will be the speaker at our next monthly meeting, May 24.

F. R. BURNHAM, *Secretary.*

---

### Cleveland Astronomical Society

Our annual dinner meeting held on Friday, May 14, proved a great success as usual. The dinner committee worked hard and a goodly number of the membership responded. Officers elected for the coming year were as follows:

| | |
|---|---|
| President | Dr. J. J. Nassau |
| Vice President | Mr. James L. Russell |
| Secretary | Mrs. S. W. McCuskey |
| Treasurer | Mrs. H. T. McMyler |
| Recording Secretary | Mr. Don H. Johnston |
| Special Project Committee Chairman | Dr. S. W. McCuskey |
| Membership Committee | Mrs. Royce Parkin, Mr. Robert S. Ingle |
| Nominating Committee Chairman | Dr. Donald Hampton |

After a splendid dinner Dr. Nassau announced that the society had now been in existence fifteen years and called on Mrs. McCuskey who gave us a very interesting history of past activities calling attention to the various noted speakers who had appeared before the society and lectured.

Dr. Nassau then introduced Professor Roy K. Marshall who lectured to us on "The Light of Nebulae." He gave us the latest information on this relatively new

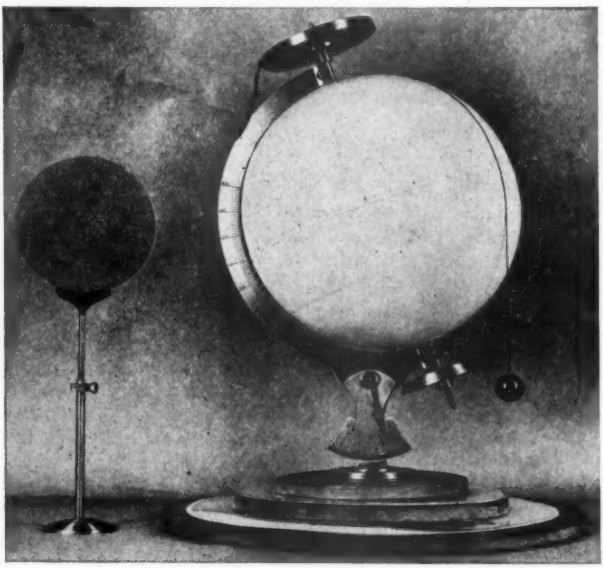
subject and related some of the most recent discoveries. Dr. Marshall received his astronomical training at the University of Michigan, Yerkes Observatory, and Harvard University. He is now Professor of Astronomy at Wilson College. He has a wide experience as a lecturer and the audience followed him readily and with enjoyment.

After the meeting was over the members gathered around the writer's new metal mirror. This was the first public appearance of this development. Curvature is obtained by flexing the thin polished disc mechanically. Russell took a sample home to experiment with in his variable star work. A sample will be sent to Buttles in Chicago and to Ingalls of the *Scientific American*.

14 Lincoln Drive, Cleveland, Ohio. DON H. JOHNSTON.

### Solar Globe

1. A most useful instrument for studying and demonstrating visible and related solar phenomena and for the re-enactment of the drama of apparent related phenomena is the Solar Globe. One is enabled to determine the re-appearance of a sun-spot group from the invisible hemisphere to the visible and to study the apparent various periodicities, the relationship and positions of sun-spot groups to terrestrial magnetic storms, the Dellenger effect, and the earth currents.



PHOTOGRAPH OF SOLAR GLOBE

2. Beginning at the top of the instrument, the upper disk controls the rotation into twenty-seven day periods. This is accomplished by setting the pressure spring into one of a series of holes drilled for this purpose. A small ivory pin is used to indicate the zero position; this pin can be seen on the upper right edge of the disk. The disk below the globe translates this rotation into degrees. On the

meridian ring is found the scale in degrees necessary for measuring the confines of the sun-spot belts. The small black sphere is suspended on a silken thread which is used to locate the central solar meridian for any time. The pedestal on which the meridian ring is pivoted is divided into degrees for measuring the position angle of the polar axis.

3. On the globe itself are scribed lines to indicate the confines of the sun-spot belts. The indicated solar equator is divided into three hundred and sixty degrees and also into twenty-seven equal parts to indicate the daily rotation period.

4. It became a problem to outline the Central Zone (the circular surface of a semi-diameter, or, that part of the sun's surface which is nearest the earth) without repeatedly marking it on the surface of the globe, or some manner of outline suspension difficult to control, until the idea of a transparent outline of a vertical glass disk was thought of. One simply moves the telescoping stand into position and the glass disk reveals the necessary outline.

5. On the middle plate of the base below the pedestal is scribed the twelve portions of the Zodiac and the division of the seasons, indicated by the polar axis of the globe. The lower plate is divided into three hundred and sixty degrees so arranged as to study the related horizontal movements of solar phenomena.

6. Acknowledgement is here made of the kind assistance of Mr. J. Mason, Principal of the Paterson Vocational School, for machining the parts for the globe which were beyond the scope of my workshop.

7. It is my desire to pass on this design to fellow research workers of solar phenomena with the hope that it might be of some little help in establishing more clearly the various relationships.

NEAL J. HEINES.

560 Broadway, Paterson, New Jersey, May 5, 1937.

### The Fifth Year of the Rhode Island "Skyscrapers"

The annual election and business meeting of Skyscrapers Inc. (amateur astronomical society of Rhode Island) was held in Wilson Hall, Brown University, on June 1, 1936. The following officers were elected: President, Mr. Franklin S. Huddy; Vice Presidents, Mr. Frederick W. Hoffman and Mr. John L. Euart; Secretary-Treasurer, Mrs. Donald S. Reed.

The program of the fifth year was as follows:

July 15, 1936. Outdoor meeting at the home of Mr. and Mrs. Frank P. Sherman, Johnston, Rhode Island.

July 1, 1936. A large delegation attended the Third Annual Convention of the Amateur Telescope Makers of Boston at Harvard Observatory, Cambridge, Massachusetts.

August 8, 1936. The Skyscrapers attended the Eleventh Annual Convention of the Springfield Amateur Telescope Makers at "Stellafane," Springfield, Vermont.

September 16, 1936. Mr. Francis Middleswart, of the Department of Mathematics of Brown University, told of his sojourn in Paris and his visit to famous European observatories.

October 7, 1936. Mr. Ernest R. Hager gave an account of "The Beginnings of Astronomy at Brown University." Miss Della Patch spoke on "Astronomical Activities in the State of Washington."

November 19, 1936. The Frank Evans Seagrave Observatory at North Scituate, Rhode Island, was purchased by Skyscrapers Inc.

November 28, 1936. Mr. Wayne M. Faunce, Vice Director and Executive Secretary of the Museum of Natural History in New York City spoke on "Planetarium Patter."

January 6, 1937. Professor Charles H. Smiley of Brown University gave a lecture on "Eclipses."

January 27, 1937. The Skyscrapers gave a farewell dinner to Professor and Mrs. Charles H. Smiley, who were leaving for a sabbatical half year in California.

February 8, 1937. Miss Victoria E. Atwell gave an address on "Astronomy and King Charles II of England."

March 10, 1937. Professor Raymond C. Archibald of the Mathematics Department of Brown University spoke on "Simon Newcomb."

April 5, 1937. Professor Lawrence C. Wroth, Librarian of the John Carter Brown Library, gave an address on "Some Early Books on the Science of Navigation."

May 5, 1937. The Fifth Annual Dinner of the Skyscrapers was held at Faunce House, Brown University. Following the dinner, the Skyscrapers and their guests heard Dr. Annie Jump Cannon, Curator of Astronomical Photographs at Harvard College Observatory, speak in Metcalf Hall, Brown University, on "Reminiscences of an Astronomer." The lecture was illustrated by lantern slides.

Last year the organization was divided into various groups for special study and the following sections have been very active during the year, meeting once a month: Constellation, Mathematics, Photographic, Meteor and Variable Star, and Telescope Making.

On November 19, 1936, the Skyscrapers Amateur Astronomical Society of Rhode Island was incorporated under the Rhode Island laws and its name was changed to "Skyscrapers Inc." On the same date, the society purchased the Frank Evans Seagrave Observatory at North Scituate, Rhode Island, which contains an 8-inch refracting telescope which was made by Alvan Clark & Son of Cambridge, Massachusetts.

The Schmidt F/1 camera, on which Mr. Harry A. MacKnight, Mr. Donald S. Reed, and Mr. Frederick W. Hoffman have been working for over a year, is now completed and has been shipped to Professor Charles H. Smiley at Pasadena, California. Professor Smiley intends to use this camera to photograph the eclipse of the sun on June 8, 1937, in Peru.

CONSTANCE H. REED, *Secretary.*

May 21, 1937.

## General Notes

**Lady Dyson,** wife of the former Astronomer Royal, died on March 25, 1937, at her home in Blackheath near Greenwich, England. She visited this country with her husband in 1932 and had an unusually wide circle of friends here.

**Dr. Alexander Wilkens,** formerly Director of the Munich Observatory, has been appointed to the staff of the La Plata Observatory, of which the Director is Dr. Aguilar appointed two years ago.

**Dr. Armin O. Leuschner,** director of the Students' Observatory and chairman of the department of astronomy at the University of California, received the honorary membership of the Rittenhouse Astronomical Society of Philadelphia at a special meeting held at the Franklin Institute on April 22. This was "in recognition of his outstanding contributions to the study of asteroids, comets, and satellites." Following the ceremony Dr. Leuschner addressed the society on "The Long Range Prediction of the Motion of the Minor Planets." (*Science*, May 7, 1937.)

**Dr. Thomas C. Poulter,** director of the Armour Institute of Technology, Chicago, who was second in command of the Byrd Antarctic expedition of 1933-35, was presented on April 27 with a special gold medal by the National Geographic Society. Dr. Gilbert Grosvenor, president, made the presentation in the presence of Rear Admiral Richard E. Byrd. A luncheon followed. On the Byrd expedition Dr. Poulter's work included geophysical investigations, studies of ice conditions, magnetic soundings, and observations of meteors and auroral phenomena. (*Science,* May 7, 1937.)

**Transit of Mercury.**—Dr. J. S. Paraskevopoulos cabled on May 11 that the transit of Mercury on that day had been observed under fair conditions and that there was no luminous ring. (*H.C.O. Announcement Card* 415.)

**The Rittenhouse Astronomical Society** of Philadelphia held a meeting on Friday, May 14, in the Hall of The Franklin Institute. After the usual dinner, a lecture on the subject, "Contributions of Geodesy to Our Knowledge of the Earth," was given by Dr. William Bowie, former Chief of the Division of Geodesy of the United States Coast and Geodetic Survey.

**Sigma Xi Lectures at the University of California at Los Angeles, 1936-37**

The following public lectures on astronomical and allied subjects have been delivered under the auspices of the University of California at Los Angeles Chapter of the Society of the Sigma Xi, in the academic year 1936-37, under the presidency of Dr. George E. F. Sherwood, Professor of Mathematics:

"Periodogram Analysis," by Dr. Dinsmore Alter, Director, Griffith Observatory and Planetarium, Los Angeles, California, on September 30, 1936.

"The Use of Magnetic Methods in Chemistry," by Dr. Linus Pauling, Professor of Chemistry, California Institute of Technology, Pasadena, on November 4, 1936.

"Earthquakes," by Dr. Beno Gutenberg, Professor of Geophysics and Meteorology, California Institute of Technology, Pasadena, on December 2, 1936.

"Bright-Line Astronomical Spectra," by Dr. I. S. Bowen, Professor of Physics, California Institute of Technology, Pasadena, on February 17, 1937.

"Transmutations of Atomic Nuclei," by Dr. Niels Bohr, Professor of Theoretical Physics, University of Copenhagen, Denmark, and Hitchcock Lecturer, University of California, Berkeley, 1936-37, on March 19, 1937.

"Visitors from Cosmic Space," by Dr. Frederick C. Leonard, Chairman, Department of Astronomy, University of California at Los Angeles, on April 7, 1937.

"Some Aspects of the Cosmic-Ray Problem," by Dr. Carl D. Anderson, Physicist in the California Institute of Technology, Pasadena, on May 5, 1937.

**American Documentation Institute**

The American Documentation Institute has been incorporated on behalf of leading national scholarly, scientific, and informational societies to develop and operate facilities that are expected to promote research and knowledge in various intellectual fields.

A first objective of the new organization will be to develop and apply the new technique of microphotography to library, scholarly, scientific and other material. It will be able to conduct scholarly publication by various methods as required by coöperating organizations.

Organized as a Delaware corporation "not for profit" but for educational, literary, and scientific purposes, the new organization resulted from a meeting at-

tended by delegates from national councils, societies, and other organizations in Washington on March 13.

The board of trustees elected consists of: Dr. Robert C. Binkley, Western Reserve University; Dr. Solon J. Buck, Director of Publications, National Archives; Watson Davis, Director, Science Service; Dr. James Thayer Gerould, Librarian, Princeton University Library; Dr. Ludvig Hektoen, Chairman, National Research Council.

Such a national organization was foreseen as an outcome of Science Service's documentation activities when they were begun in July, 1935, implemented with grants from the Chemical Foundation and conducted with the coöperation of the U. S. Naval Medical School, the U. S. Department of Agriculture Library, the Bureau of the Census, the Works Progress Administration, the Library of Congress, and other agencies.

Bibliofilm Service has been conducted by Science Service in coöperation with the Library of the U. S. Department of Agriculture as a service to research workers, and auxiliary publication through microfilm has been conducted by coöperation with leading scholarly and scientific journals. Science Service's documentation activities will be transferred to the new American Documentation Institute.

April 20, 1937.

## '37 Down the Centuries in Astronomy*

1437: The Tartar astronomer Ulugh Beg (1393-1449), Prince of Tartary, published his celebrated Catalogue of 1018 stars,[1] composed by him and his collaborators in his observatory at Samarkand. From the days of Ptolemy (IInd Century A.D.) to 1437 no other stellar catalogue had been made on a basis of original observations.

1537: The astronomer and mathematician Christopher Clavius was born in Bamberg. After entering the Jesuit Order he took part as one of the principal workers in the reform of the calendar ordered by Pope Gregory XIII in 1582.

1637: The illustrious Galileo Galilei, living in retirement at Arcetri, lost his eyesight in this year.

1637: Benedetto Castelli divined the existence of the Australian continent on the basis of the so-called ashy light (earth-shine) of the moon. As is well known the earth-shine shows us the dark part of the moon which otherwise would remain invisible; it is nothing else than the earth's light striking upon the moon, and is accordingly the reflection of a reflection. By carefully observing the intensity of the earth-shine we can determine what region of the earth is reflecting it: when it is the ocean the light is very weak; when it is a bright region like the Sahara or a great expanse of snow, or banks of clouds, the light is more vivid. From these observations on the intensity of earth-shine in relation to the reflecting region Castelli suspected the existence of "Southern lands unknown to us." His close friend Galileo fully supported his conclusions, and thus the existence of Australia was surmised by means of astronomical observations a few years before it was actually discovered.

1737: In 1737 (November 13) at a session of the French Academy of Sciences, Maupertius reported the results of the celebrated geodetic expedition to Lapland to measure an arc of meridian. It definitely confirmed the flattening of the earth

*From the Diaries of Pio Emanuelli, translated by Dr. H. Loss, Carleton College.

[1] Republished in 1937 by the Carnegie Institution, Washington, D. C., as *Ulugh Beg's Catalogue of Stars;* E. Ball Knobel, ed.

at the poles.

1837: The German astronomer Argelander demonstrated that the conclusion Wm. Herschel had reached in 1783 and 1805 about the movement of the sun in space was confirmed securely by a series of his own resarches.

1837: Bessel applied the heliometer to determine the stellar parallax of 61 Cygni. This may be considered the first parallax to have been deduced with certainty. Struve almost contemporaneously determined by another method the parallax of $\alpha$ Lyrae.

1837: Beer and Mädler published their great work "The Moon," which may be judged the result of the first trigonometric determinations of the lunar surface.

1837: F. G. W. Struve published his *Mensurae Micrometricae* giving the position, angle of position, angular distance, color, and relative brightness of 3112 double and multiple stars.

---

**The Date of the 2000th Anniversary of the Birth of Augustus**

In the Italian astronomical journal *Coelum* (March and April, 1937, Vol. VII, pp. 54-57, 75-78), Professor Pio Emanuelli of Rome has published two papers on the correct determination of the year and day of the bimellennary of the birth of Augustus.

Augustus was born in the year 63 B.C., *i.e.* $-62$; therefore the bimellennium will occur in the year 1938 ($2000 - 62 = 1938$), and not in 1937 as some people think.

The day of the birth is 23 September 63 B.C. in extrapolated Julian Calendar, which corresponds to 21 September 63 B.C. in extrapolated Gregorian Calendar.

There are two solutions for the day of the recurrence, one in Julian and the other in Gregorian Calendar:

In Julian Calendar—

1938 September 23 (old style)
1938 October 6 (new style),

In Gregorian Calendar—

1938 September 8 (old style)
1938 September 21 (new style).

---

## Book Review

**Magnetic Declination in the United States,** 1935, is the title of a pamphlet by Daniel L. Hazard and W. N. McFarland. Recently published by the United States Department of Commerce, it contains the magnetic work of the United States Coast and Geodetic Survey. It is procurable from the Superintendent of Documents, Washington, D. C., for a modest price. The pamphlet contains a wealth of material for the land surveyor, the aviator, the prospector, the amateur astronomer, as well as for all others who have occasion to use a compass and are anxious to know to what degree their instrument is in erorr. In addition to containing tables and charts denoting diurnal and secular changes, it has a twenty-four by thirty-inch map of the United States, surrounding territory and waters, showing lines of equal magnetic declination and of equal annual changes, as well as directions for the understanding and interpretation of the recorded data. Its intelligent use can be of value to anyone.

GEORGE GWINN.